Guidelines for the use of technology in higher education based on human computer interaction principles from a Dooyeweerdian perspective

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Abstract

The purpose of this study is to develop guidelines for the use of technology in higher education, based on human computer interaction principles, from a Dooyeweerdian perspective.

The literature review laid the theoretical foundations for this critical social theory study, with interpretivism as supporting paradigm. The five step action research method has been selected in support of the critical study. The set of six principles used when conducting critical studies in IS, along with the set of seven principles used when conducting interpretive field studies in IS guided data collection and analysis of the study. The organised use of rational thought; which includes a framework of ideas, a methodology and an area of concern, guided these elements in the study.

The three action research interventions conducted in this study were preceded by the contextualisation of the research in terms of the repeating (R) and newcomer (N) students, the subject modules of systems analysis and design, and the three focal points of instructional design, formative guidance, and summative assessment.

Two outcomes were anticipated, the first was the extraction of guidelines for the use of technology. In preparation for action research Cycle R, human computer interaction (HCI) principles were derived from extant literature, and the framework for technological, pedagogical and content integration (TPACK) applied to obtain initial guidelines. Action research Cycle R were utilised to verify and refine these guidelines to obtain updated HCI-TPACK guidelines.

The derived human computer interaction foci already extracted, were also utilised in action research Cycle N, and the aspectual engagements framework (AEF), developed by Basden, and based on the work of Dooyeweerd. By applying aspectual analysis to the 15 modal aspects in the context of the three focal points, conceptual guidelines were obtained. Action research Cycle N were utilised to verify and refine these guidelines to obtain enhanced HCI-AEF guidelines.

The second anticipated outcome, was the emancipation of the systems analysis and design students, to enable them to reach their full potential. The two parallel action research cycles facilitated this.

From the updated and enhanced guidelines, generalised guidelines were formed, and a third action research cycle was conducted with a combined class of all students. The three focal points were improved according to the generalised guidelines, and demonstrated and evaluated to determine its success after the first partially improved class offering. The feedback obtained was positive, indicating success, with a future fully implemented action research cycle envisaged for 2020.

Keywords: technology in education, framework for technological pedagogical and content knowledge interaction, human computer interaction, Dooyeweerdian philosophy

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The three anomymous examiners appointed to assess this thesis, provided me with insight on my final document, which allowed me to continue weaving the golden thread and fill gaps still existing in my argument.

Declaration

I, Imelda Smit, declare that:

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is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

Signature: ________________________________ Date: _______________________

Acronyms

A	The area of concern (application) is supported by an identified body of knowledge from literature
AEF	Aspectual engagements framework
AR	Action research
C	The contributions to $F_{A,}$ F_I, $M_{R,}$ M_{PS}, A and P
CST	Critical social theory
DSR	Design science research
EIT	Engaging with interface and technology, broadening the scope of the AEF functioning to include both the information mediating interface (referred to as HCI in the HUC), as well as the underlying technology supporting the artefact
ELI	Engaging in life with IS, including life at work and life outside of work, an AEF functioning
EMC	Engaging with meaningful content – the user's experience of meaning in terms of content as represented by the artefact, an AEF functioning
ETHICS	Effective technical and human implementation of computer-based systems
ERC	Engagement with represented content, a HUC functioning
F	The intellectual framework of ideas supporting A
F_A	Specific concepts from literature supporting A
F_I	General concepts from literature informing a study independent of A
FFU	Framework for understanding
GT	Grounded Theory
HCI	Human computer interaction, a HUC functioning; the interaction between user and computer from the user's perspective, this includes the hardware and the user interface of the software Human computer interaction
HLC	Human living with computers – what the user experience when using the computer in daily living, a HUC functioning
HUC	Human use of computers
IS	Information Systems
I	General concepts independent of A supported by an identified body of knowledge from literature
IT	Information technology
L	Learning that takes place regarding F, M and A
M	Methodology identified to be used in the research study
MIMA	Mobile instant messaging application (an example of a tool is WhatsApp)
M_{PS}	Methods informing the problem solving cycle
M_R	The methods informing the research cycle
MAIT	Multi-aspectual interview technique
MAKE	Multi-aspectual knowledge elicitation
P	The problem situation that is owned by the stakeholders
PS	The problem solving cycle which focuses on producing pragmatic outcomes
R	The research cycle to be utilised in the research study to produce research outcomes

S	The scope of a study consists of the union of the involved and the affected, the sum total of those living, now or in the future, the social system in question in a research project
SA&D	Systems analysis and design
TPACK	Framework for technological pedagogical and content knowledge interaction

A note on acronyms:

This list of acronyms were created to assist the reader with their interpretation. Even with this tool included, acronyms have been used with care. Throughout this thesis, in the introduction of a chapter, the author refrained from using acronyms. The first time a concept is referred in a particular chapter, the full definition with the abbreviation in brackets is given; after which the abbreviated form is used. The exceptions to this rule are the use of acronyms (1) in tables and figures to utilise limited space effectively, (2) which occurred in a chapter – in the summary of that chapter, and (3) in the concluding chapter of the thesis. To facilitate the recognition of acronyms in these instances, the table supplied here, should be consulted.

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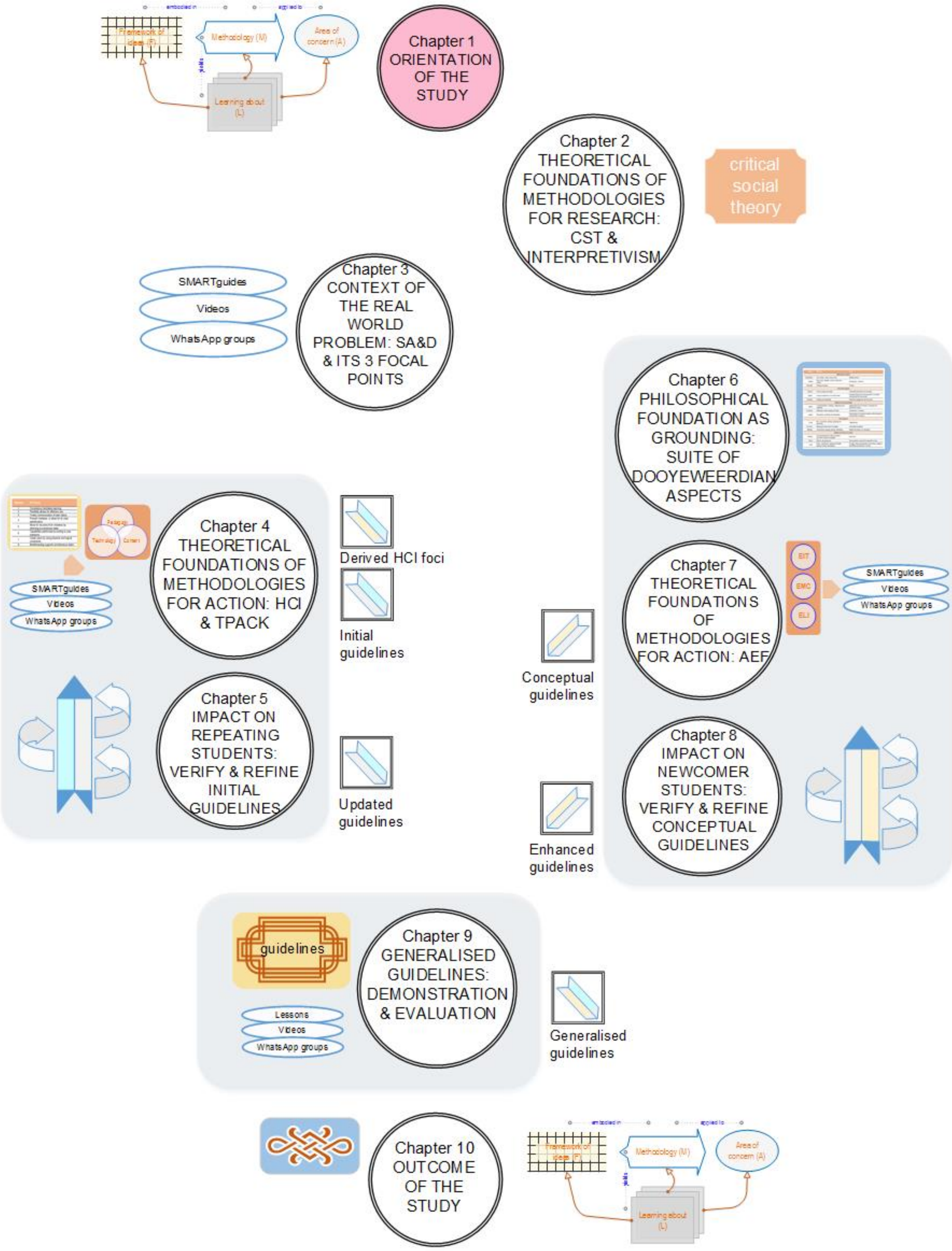


1 ORIENTATION OF THE STUDY

1.1 CONCEPTS KEY TO THE STUDY

Four concepts are key to this study, namely the principles for guiding human computer interaction (HCI), the framework for technological pedagogical and content knowledge interaction (TPACK), the Dooyeweerdian suite of modal aspects, which guides the use of technology in education in the context of the aspectual engagements framework, formerly referred to as the human use of computers, of which HCI forms an integral part. The research methodology relevant to this study, is the fourth concept that is key to this study.

1.2 INTRODUCTION

In teaching and learning, technology can only be the vehicle through which the subject content is delivered. The delivery of content is subject to a teaching strategy, based on learning theories, the differentiation of teaching and learning approaches and an assessment plan. To add to a complex situation, it is humans as individuals which need to teach, and be taught and learn. When compared to technological devices, humans have a limited capacity to process information, limited input and output channels, limited memory capacity and limited reasoning processes (Dix *et al.*, 2004:13). Humans are individuals whom experience a variety of emotions. All these factors have an impact on how humans engage with technology when learning.

In this research project, second year students studying information technology and enrolled for the subject systems analysis and design, are guided through the use of technology by utilising the following: an electronic interactive learning guide, referred to as a SMARTguide, for instructional design; videos on challenging concepts allowing students to study these concepts in their own time – repetitively and with the inclusion of stops and starts as they desire, for formative guidance; and using a mobile instant messaging application to allow students lecturer and peer support, while preparing for summative assessments. Although the mentioned tools are not the only ones, these three focal points are the main purpose of this study.

From the above, two information systems concepts emerge as central to this study, namely the application of HCI principles manifesting when humans use computers; and the use of technology in education, a vehicle for educational design and delivery. To make sense of the use of technology in education, extant literature on HCI principles is scrutinised, and the framework for TPACK interaction, suggested by Mishra and Koehler (2006) is investigated. The suite of 15 modal aspects is used as the philosophical grounding of this study, while the aspectual engagements framework for understanding, based on the suite of Dooyeweerdian aspects (Dooyeweerd, 1969) and developed by Basden (Basden, 2008; Basden, 2018), guides the study.

In the subsequent sections, the following are covered; concepts key to the study (§1.1), the problem statement (§1.3), elements relevant to this study (§1.4), the objectives of the study (§1.5), the research design (§1.6), ethical considerations (§1.7), the chapter classification (§1.8), as well as a summary concluding this chapter (§1.9).

1.2.1 HCI principles

Human computer interaction guides the designer on how to design computer implementations, as well as how the users of these systems will use them to enhance their work; and in the case of this research – their teaching and learning. Important in this study is the identification of the important principles applicable to HCI, which is discussed in Chapter 4. The investigation and mapping of eight design rules (Shneiderman, 1992), ten heuristics (Nielsen, 1994), seven fundamental principles (Norman, 2013), and multiple usability principles (Dix *et al.*, 2004) highlights the HCI principles to be used to guide this study. These HCI foci are then compared to that of Hinze-Hoare (2007) with the purpose of unification. Chapter 4 addresses HCI and the identification of the derived HCI foci that will guide this study.

1.2.2 Framework for TPACK interaction

According to Mishra and Koehler (2006:1020), *what* people learn and *how* people learn in education are equally important. They developed a model that supports the co-existence of content, pedagogy, and technology in education. The model they developed is shown in Figure 1.1 and is important for this study is discussed in Chapter 4.

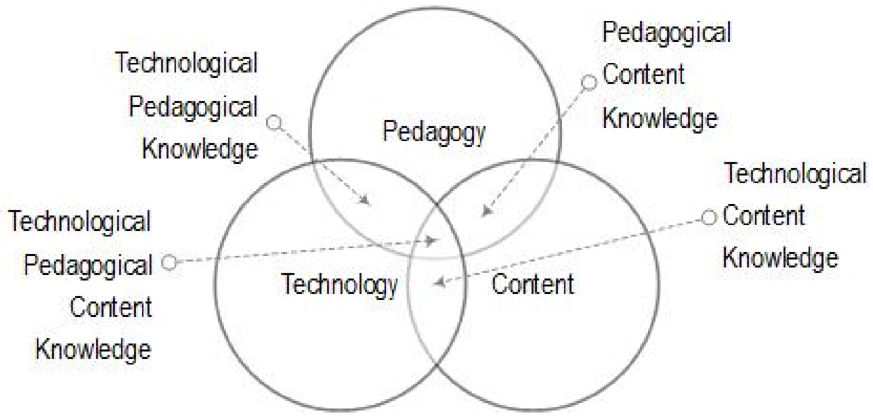


Figure 1.1: TPACK model, adopted from Mishra and Koehler (2006:1025)

Content Knowledge (CK) is specific subject matter, taught to people to enable them to learn (Mishra & Koehler, 2006:1027), but there is more to this endeavour; Shulman (1986) suggests that the nature of knowledge and its corresponding enquiry may differ across disciplines.

Pedagogy Knowledge (PK) is not discipline specific, and requires classroom planning and management: lessons to be offered for learning to take place, the learning itself, and assessment of the learning (Mishra & Koehler, 2006:1026).

Technology Knowledge (TK) is also not discipline specific, especially with multiple tools existing, of which many are not developed with education in mind. Since technology is so important in our daily lives, it also established itself in education; necessary as meta knowledge, as well as instruments to (re)present content knowledge, do demonstrations, and assess learners (Mishra & Koehler, 2006:1023).

The three knowledge versions are presented as spheres intersecting with one another, representing three additional knowledge categories, namely: content-pedagogy, content-technology, and pedagogy-technology. A fourth category of knowledge identified by Mishra and Koehler (2006), exists at the intersection of the three spheres – content-pedagogy-technology knowledge.

1.2.3 The Dooyeweerd suite of fifteen modal aspects

The work of Herman Dooyeweerd (1894-1977), a Dutch philosopher who developed fifteen modal aspects, stands central to this study and is discussed in Chapter 6. It provides a framework for theoretical thinking and understanding reality; guiding the understanding of learning in Information Systems (IS) within the South African context, in combination with utilising technology, used in this study as a vehicle for learning an IS subject.

An important part of Dooyeweerd's philosophy is his theory of modal aspects in which he discusses fifteen aspects of reality. Dooyeweerd (1969:4) argues that it is possible to describe all aspects of reality in terms of these fifteen modalities. In Table 1.1, the aspects are listed and each one illustrated with examples of what is qualified by the aspect. Each aspect has a kernel of meaning along with retrocipation and anticipation of other aspects. By its retrocipation and anticipation of other aspects (Basden, 2008: 70), each aspect inherently relates to the others. Retrocipation is when an aspect reaches back to an earlier aspect. Anticipation is when an aspect reaches forward to a later aspect. In this way meaning of an aspect is formed – we have a kernel of meaning along with retrocipation and anticipation of other aspects.

Table 1.1: The fifteen modal aspects of reality identified by Dooyeweerd; listed as types of things by qualifying aspect as discussed by Basden (2008:25)

Aspect	Example things
Quantitative	Amount, Proportion < representing quantity >
Spatial	Shape, Distance, Angle, Direction <representing size>
Kinematic	Path or route, Flow <representing movement>
Physical	Solids, Fluids, Gases; Energy, Waves, Particles, Materials, Fields, Forces < representing interaction>
Biotic	Plants; Organism, Organ, Tissue, Cell; Animals < representing life functions>
Psychic	Sound, Colour, Feeling, Emotion, Excitation < representing feeling and sensing>
Analytic	Concepts; Distinctions, Deductions, Awareness < representing concepts and logic>
Formative	Goal, Achievement, Forming, Will, Tool, Skill < representing history, culture and technology>
Lingual	Word, Sentence, Book, Writing, Utterance, Diagram, Index < representing communication>
Social	Friendship, Institution, Status, Respect < representing relationship and community>
Economic	Resource, Limit, Production & consumption, Money, Management < representing skilled use of resources>
Aesthetic	Music, Sculpture, Cuisine, Humour, Fun, Sport, Nuance < representing interest and fun>
Juridical	Responsibility & rights, Reward & punishment, Laws < representing rights and responsibilities>
Ethical	Act of generosity, Sacrifice < representing love and generosity>
Pistic	Religions, Ideologies; Faith, Trust, Loyalty, Worship, Commitment, Ritual < representing faith, commitment and vision>

Another important part of Dooyeweerdian thinking is the theory of individuality structures. An individuality structure refers to a concrete entity or event which has special qualities distinguishing it from all other individuality structures (Kalsbeek, 1975:42-43). When we work with individuality structures, we always ask the question: *what*, while with aspects the question is: *how*, since it concerns itself with the manner of being - a mode. Therefore, Dooyeweerd refers to them as *modal* aspects. Furthermore; when an individuality structure is analysed theoretically, it is crucial to start with the modal aspects - only then can the researcher understand the entity as a whole.

In Chapter 7 the discussion of the work by Dooyeweerd, is expanded. Basden (2008) bases his work on the philosophy of Dooyeweerd – to provide frameworks of understanding in a technological context. One framework in particular, the aspectual engagements framework (AEF), is of value to this study (Basden, 2008; Basden, 2018). The AEF frames complex human engagements that may be understood through a multi-aspectual approach (Basden, 2018): engaging with interface and technology – interaction between the user and an information mediating interface with its underlying supporting technology should be *easy to use* and is qualified by the lingual aspect; engagement with represented content – the user experience regarding meaning of content, represented by the artefact, should be *truthful* and its qualifying aspect is reflected by the purpose of the IS; and engaging in life with IS, both life at work and life outside-of-work, should be *useful* with the artefact determining the beneficial value that realises. Basden (2008:153) suggests a number of instruments to be used in aspectual engagements reflection research practice, namely aspectual analysis, aspectual checklists and aspectual trees. Such aspectual engagements reflection should be verified through interviewing; of which the techniques of Winfield (2000) – multi-aspectual knowledge elicitation (MAKE) and Kane (2005) – multi-aspectual interview technique (MAIT), are available.

1.2.4 Perspectives in IS research

An introduction to research paradigms sets the background to the perspective applicable to this study. Following setting the view of the world held by the researcher, the elected matching research methodology, data collection, and analysis preferences are subsequently set.

Relevant to IS research, Myers (1997) suggests three paradigms, while Hevner and Chatterjee (2010) suggests a fourth. These four paradigms in IS research, namely positivism, interpretivism, critical social theory (CST), and design science research (DSR), are considered for this study:

Positivism: According to Myers (1997) positivists work from the assumption that the world is ordered and regular, not random and that we should investigate it objectively to find universal laws and patterns. Proof and measurement are important and often a theory is tested. Research in IS, is classified as positivist when inferences can be drawn from a sample of a population to the full population regarding a phenomenon; also when a hypothesis can be tested.

Interpretivism: the interpretive researcher perceives the world as a social setting, with people who have multiple views (Myers, 1997). Here it is important to make sense of reality and to form a rich understanding. A theory or framework for understanding is developed. Research in Information Systems is classified as interpretive when an attempt is made to understand phenomena through the meaning people attach to it, this meaning may differ between cultures (Myers & Klein, 2011:21; Richardson & Robinson, 2007:261).

Critical social theory: the critical researcher is concerned with identifying the power relation, conflicts and contradictions existing in the situation and the empowerment of people to enable emancipation on a social, cultural or political level (Myers, 1997). A social reality is created (produced) and recreated (reproduced) by the people functioning within the social context. The aim is to remove unfairness.

Design science research: the design researcher builds and evaluates and utilises a body of knowledge about man-made objects or phenomena designed to meet set goals (March & Smith, 1995:253). It seeks to solve problems from a fundamental point of view, which classifies the design scientist as a problem solver creating innovative solutions which may result in ideas, designs, or products Hevner *et al.* (2004:76). The acceptance of DSR as a legitimate paradigm in IS research, is an on-going debate. With Gregor and Hevner (2013:337) arguing for the metaphysical assumptions legitimising the paradigm, it is treated as a paradigm in this study.

The critical social theory perspective is applicable to this study. The justification of its use follows in Section 1.6.2.

1.2.4.1 Research methodology

Myers and Klein (2011:25) compiled the set of six principles to be used when conducting critical social theory in IS. The set of six principles is categorised into two elements: that of critique which includes using core concepts from critical social theories, taking a value position, and revealing and then challenging existing beliefs and social practices; and that of transformation which includes the emancipation of the individual, effecting improvements in society, and improving social theories.

What Myers (1997) calls strategies of inquiry, Creswell (1998:2) epithets traditions of inquiry. Between these two authors, six qualitative strategies of inquiry emerge, namely biographical study, phenomenological study, ethnography, grounded theory (GT), action research (AR), and case study research (CSR). The strategy of inquiry that is relevant to this study, namely AR, is also discussed as research method.

AR is a five step interactive process and is used in each focal point as follows (Susman & Evered, 1978:588):

- *Phase 1: Diagnosing*, which has the purpose of holistically interpreting a complex situation to identify problems which needs to be addressed to enable the institution to progress, possibly through change.
- *Phase 2: Planning for action* involves the specification of actions that need to be taken to relieve the problems identified; the discovery of planned actions to enable change will allow the institution to progress towards a desired future state. The target for change, as well as the approach to change, needs to be addressed by the planned action.
- *Phase 3: Taking action* uses the actions planned for implementation. The researcher, along with the participants intervenes actively – to enable change.
- *Phase 4: Evaluation* has the purpose of determining whether the action taken relieved the problems identified, and realised the theoretical effects. Change may be successful or unsuccessful.
- *Phase 5: Learning specified* should be an on-going process and knowledge should be gained whether the action taken was successful or unsuccessful. First, a successful intervention may result in restructuring institutional norms that reflect new knowledge gained. Second, an unsuccessful intervention may provide the foundation for the diagnosis of the next research cycle. Third, whether the intervention was successful or not, the research may provide useful knowledge to the scientific community regarding future research.

This research project implements two AR cycles which focus on three focal points in the context of second year students studying the subject systems analysis and design

(SA&D) in an information technology (IT) course. The implementation is discussed in more depth in Section 1.6.2.

1.2.4.2 Data collection

This study falls in the qualitative tradition of inquiry, where the focus is on what is labelled as in-depth, explorative, semi-structured, or un-structured (King, 2004:11). Although the approaches to interviews differ, the ultimate goal is to see the implementation environment through the eyes of the participants, and their particular points of view. Therefore, in the context of a qualitative study, little structure should be imposed on the researcher, allowing open questions to be answered by the participant, with the focus placed on specific events. The study being critical in nature, and relying in part on the AEF which is based on the Dooyeweerdian philosophy, one derived data collection technique, MAKE (Winfield, 2000), is discussed in Chapter 7.

1.2.4.3 Data analysis

The two data analysis techniques relevant to this study, are Hermeneutics and Content Analysis. The two techniques are discussed in short.

Hermeneutics can be both utilised as an underpinning philosophy and a mode of analysis (Bleicher, 1980:97). As an underpinning philosophy, the Hermeneutic Circle is included as the fundamental principle of interpretivism, providing the philosophical basis towards understanding human behaviour. Its alternative use as mode of analysis, provides a way to understand textual data or an analogue for text. According to Radnitzky (1970:20) Hermeneutics ask the basic question; namely "*what is the meaning of the text or text analogue?*". Taylor (1976:153) suggests that this implies that the text is not clear, possibly confusing to the reader, not complete, or sections of the text may contradict each other, and interpretation may attempt to make sense of the parts and the whole and shed light on the underlying coherence of the text or text analogue.

Content analysis as method allows the researcher to qualify and/or quantify phenomena in a systematic way, and its purpose is to facilitate understanding of the data while being objective (Elo & Kyngäs, 2008:108). Elo and Kyngäs (2008:109) suggest three phases of content analysis, namely: preparation, where the researcher makes sense of the data and organise it in themes; organising, where the researcher categorises the data in a trustworthy and reliable way; and reporting, on the process and results of the analysis.

Having a basic understanding of the concepts key to the study, it is possible to unpack the problems that necessitated this study.

1.3 PROBLEM STATEMENT

It is necessary to consider the purpose of this study; namely; to develop guidelines for the use of technology in higher education based on HCI principles from a Dooyeweerdian perspective.

In the South African context, students and academics, of which the North-West university's Vaal Campus students, and teaching staff are part, face specific challenges. Although a solid infrastructure is in place with regards to teaching and learning facilities, including the library and its supporting facilities, theory classes and practical laboratories, students also have a need to study and work off-campus, especially during busy times when projects are nearing deadlines and formative and summative assessments are conducted. Many students are not affluent enough to access electronic and other university resources after hours, or to buy their own (computer, smartphone, and air time and text books) and are therefore reliant on their notes and whatever other resources they may have access to. Students also do not have easy access to their peers when they are off-campus, especially when they live on their own. At the same time, while keeping in mind that the students included in this study are IT students – these students are intrigued by technology and everything it facilitates and supports. Unfortunately, this generation's students' studies compete with the time they spend on their electronic devices.

The above scenario leaves teaching staff with a number of challenges. When a module such as SA&D has a large volume of work, questions such as "*how can the student be supported when learning?*", "*is it possible to allow the student more than one way to learn?*", and "*are there any structures outside the university environment that may be implemented to support the student?*", are paramount in the mind of educators. Therefore it may be wise to include technology in a student's repertoire of tools. But, since most applications require current technology to run, care should be taken to address the issue in such a way to ensure all students have easy access to it.

This study aims to fill a gap in the literature regarding the development of guidelines based on human computer interaction principles, from the perspective of a theoretical framework, to direct the use of such technology in the teaching and learning of systems analysis and design.

The research question for this study can therefore be formulated as:

How can guidelines, based on human computer interaction principles, be compiled to direct the use of technology in higher education – from the perspective of a theoretical framework?

1.4 ELEMENTS RELEVANT TO THIS STUDY

The model of Checkland and Holwell enables the understanding of the environment in which such questions are asked, as well as the questions themselves; it also facilitates the process followed to address these questions in a research project, ensuring that underlying assumptions, modes of inquiry, and the validity of the research is argued in an AR study (Checkland & Holwell, 1998a; Checkland & Holwell, 1998b:23). This model for the organised use of rational thought is depicted in Figure 1.2 and includes a number of components: namely a framework of ideas (F), which relates to an underpinning philosophy guiding the study; a methodology (M), which indicates *how* the study should be performed, as well as *what* should be done; an area of concern (A), which includes the focus of the study in terms of its context and implementation; and learning (L) that takes place in all the areas (FMA). F, M and A form the intellectual structure of a study and should be declared in advance; the study then proceeds to test the adequacy of F and M, and the appropriateness of A.

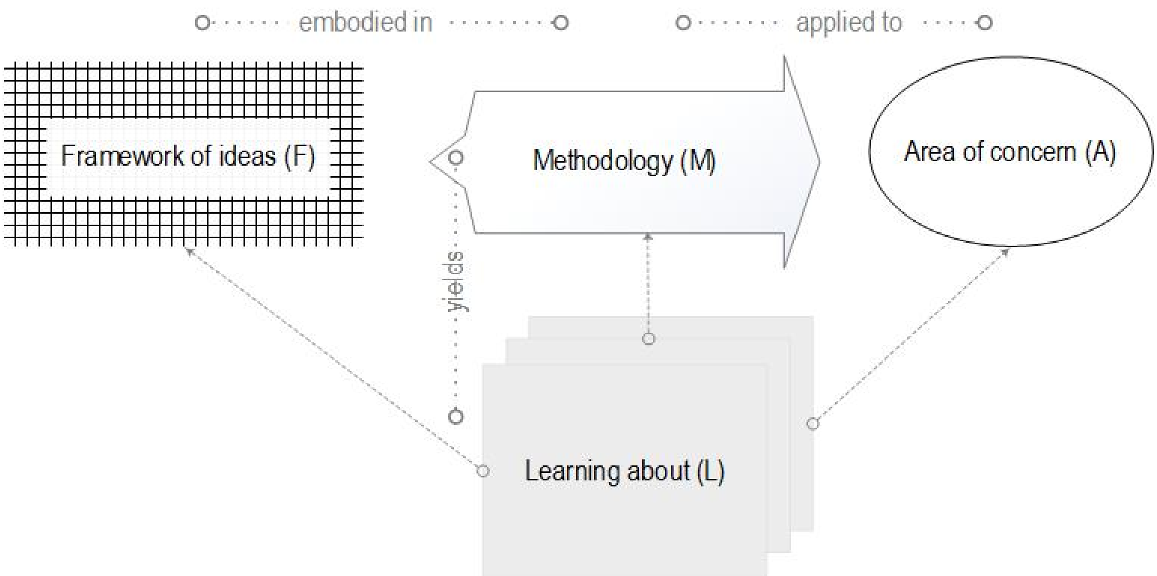


Figure 1.2: The organised use of rational thought; redrawn from Checkland and Holwell (1998b:23)

Figure 1.2 is amended to include the elements relevant to this study in Figure 1.3.

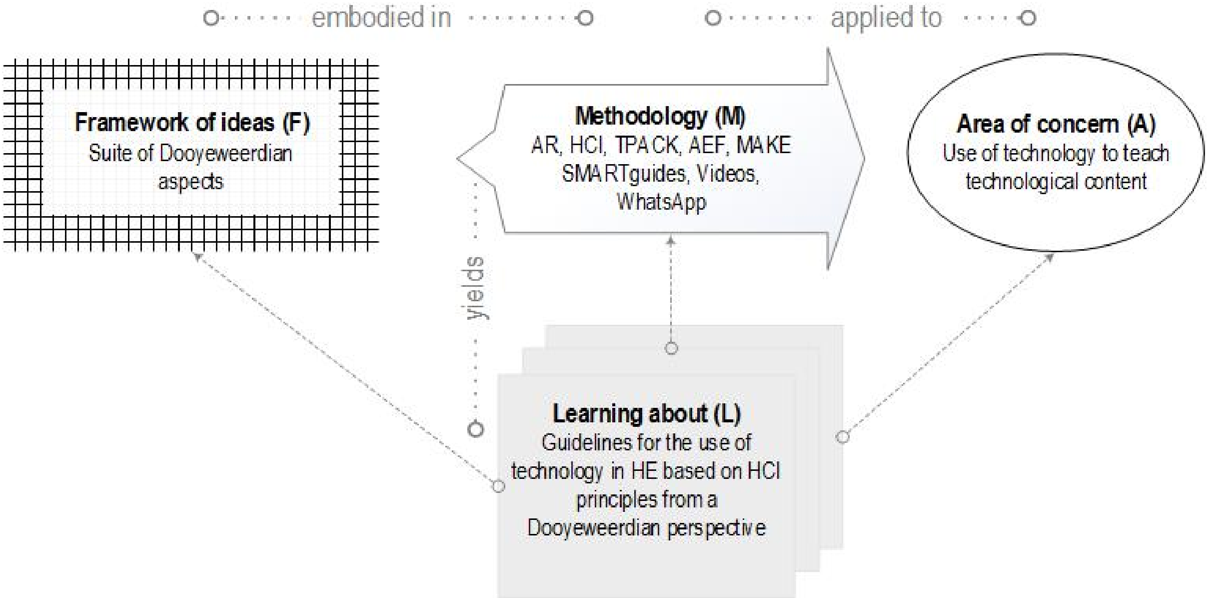


Figure 1.3: The elements relevant to this study

This process facilitates the identification of research themes, from which lessons are learnt. The ultimate goal is to ensure the recoverability of the process followed by an AR study: the documentation of the models used and the thought processes followed to interpret themes for the purpose of drawing conclusions to be able to generalise results to ensure its transferability (Checkland & Holwell, 1998a:18).

The work of Dooyeweerd (1969) is used as this study's intellectual framework (F). Critical social theory also supports F by supplying the research framework.

The framework for TPACK interaction developed by Mishra and Koehler (2006), as well as the Basden-developed AEF (Basden, 2018), based on Dooyeweerd's modal aspects (Dooyeweerd, 1969), facilitates methodologies (M) from a technological point of view. The principles for conducting critical research compiled by Myers and Klein (2011) facilitates the study from the research perspective, in support of M.

The aspectual analysis techniques suggested in the AEF is applied to the three focal points, each focusing on a different aspect of education, namely; instructional design, formative guidance and summative assessment situated in an IS instructional setting at a South African university as the area of concern (A). Human computer interaction principles are guiding the formulation of guidelines derived from the analysis of the three cases, also in support of A. AR is a research method applied to the SA&D teaching and learning environment and utilised by this study in support of A.

The FMA model discussed here, has a dual nature. In Chapter 2 (§2.6.2.3) this duality is investigated. The expanded model may facilitate the detailed distinction between the different foci of F, M and A. Initially McKay and Marshall (2001) partly expand the FMA model, while Mathiassen *et al.* (2012) complete the refinement.

The aim is to learn (L) about:

- *The framework of ideas (F)*: Dooyeweerd's suite of modal aspects, critical social research, and to a lesser extent, interpretivism.
- *The methodology (M)*: the human computer principles, the framework for TPACK interaction, the AEF, the principles for critical social research, and to a lesser extent the principles guiding interpretive research.
- *The area of concern (A)*: the SA&D teaching and learning environment by using technology tools in the form of the three focal points.

1.5 OBJECTIVES OF THE STUDY

The objectives in this study include the overarching primary objective with the theoretical, reflective, and empirical objectives informing it.

1.5.1 Primary objective

To present derived guidelines for the use of technology in higher education, based on HCI principles, from a Dooyeweerdian perspective.

1.5.2 Theoretical objectives

In order to achieve the primary objective, the following theoretical objectives are formulated:

T01. To explore the extant IS paradigms with its corresponding methodologies, methods and techniques to be able to determine the suitable research design(s) for the study.

T02. To enquire the potential integration of technology into teaching and learning to enhance academic success. As guiding lens, the HCI principles is used. The framework for TPACK interaction is considered in support of the HCI principles.

T03. To investigate how the ideas, and specifically the fifteen modal aspects of Dooyeweerd can be used to gain understanding of using technology to learn. The suitability of the AEF, which uses the suite of modal aspects developed by Dooyeweerd, as methodology to ascertain the successful integration of technology into teaching and learning, is determined.

1.5.3 Reflective objectives

In order to achieve the primary objective, the following reflective objectives are formulated:

R01. To place the study in the context of the student, who stands central to this study, the subject content of SA&D which is studied, and the three focal points in support of the study.

R02. To use the framework for TPACK interaction, to make sense of this study:

- To extract a list of derived HCI foci applicable to this study - from extant literature on HCI principles.
- To utilise the framework for TPACK on the derived HCI foci to assimilate initial guidelines for this study with regard to the three focal points identified.

R03. To utilise the AEF which suggests aspectual reflection, to analyse and make sense of this study:

- To prepare a HCI analysis matrix, based on the derived HCI foci already obtained, by using the AEF. This framework suggests the use of an aspectual checklist with the goal of identifying gaps in the HCI foci extracted from literature.
- To employ aspectual analysis to enable the extraction of conceptual guidelines for this study with regard to the three focal points identified.

1.5.4 Empirical objectives

In order to achieve the primary objective, the reflective objective is supported by the following empirical objectives:

E01. To apply the five-step AR cycle to guide the verification and refinement of the initial guidelines obtained in reflective objective (R02) – with the concurrent purpose to improve the student experience of repeating students. Three technological instruments which are represented by the three focal points of instructional design, formative guidance, and summative assessment, form part of this cycle. The evaluation is guided by the implementation during the AR cycle which uses the HCI foci and the framework for TPACK interaction to refine the guidelines obtained from the evaluation of each AR cycle. The cycle utilises qualitative data gathering and analysis techniques applicable to the cycle.

E02. To apply the five-step AR cycle to guide the verification of the conceptual guidelines obtained in reflective objective (R03) – with the concurrent purpose to improve the student experience of newcomer students. Three technological instruments which are represented by the three focal points of instructional design, formative guidance, and summative assessment, form part of this cycle. The evaluation is guided by the implementation during the AR cycle with its culmination in the utilisation of the AEF to refine the guidelines. The cycle utilises qualitative data gathering and analysis techniques applicable to the cycle.

E03. To apply the five-step AR cycle to guide the demonstration and evaluation of the generalised guidelines – with the concurrent purpose to improve the student experience. The three focal points of instructional design, formative guidance, and summative assessment, are amended according to the generalised guidelines. The evaluation is tested by the success of the intervention. The cycle utilises qualitative data gathering and analysis techniques.

1.6 RESEARCH DESIGN

In support of the objectives discussed in the previous section, the research design and methodology are addressed in this section.

1.6.1 Literature review

Searches will be conducted on databases such as EBSCOhost and Google Scholar. The key words to be used are:

- Research paradigms: "*research paradigms in information systems*", *research methodologies in information systems*".
- Human computer interaction: "*human computer interaction*", "*human computer interaction principles*".
- Dooyeweerdian philosophy: "*15 Dooyeweerdian modal aspects*".
- Technology in education: "*technology in education*", and "*framework for technological pedagogical and content knowledge interaction*".

1.6.2 Empirical research

In order to provide a justification for the selection of a research paradigm for this study, it may be viewed as being situated in an educational setting with students and other stakeholders who have multiple views on the teaching and learning process. The aim of the study is to make sense of the complexities to such an extent that the deconstruction of the setting is possible. This should happen in such a way that oppressing factors may be addressed to enable the reconstruction of the setting to emancipate the stakeholders. With this premise in mind, positivism, seeing the world as orderly and therefore to be investigated objectively, is not a suitable paradigm for this study. Interpretivism, which seeks to understand the multiple views of people in a social setting, is important in this study, but not the primary focus. DSR, which aims to build-and-evaluate artefacts, has been utilised to build the SMARTguides-as-artefacts, but this part of the study is not the focus of the study either. With its ultimate purpose to remove unfairness, CST addresses the need to identify power relations within SA&D with the purpose to allow students to develop their full potential by recreating the environment.

With CST as the selected paradigm for this study, AR is used to describe the development of the SA&D subject through its subject modules – over an extended period of time. This is conducted through a CST lens with the principles of Myers and Klein (2011:25) guiding it. The focus moves to the three focal points, namely instructional design, formative guidance and summative assessment, as part of SA&D.

A number of data gathering and analysis techniques are used in this study, with interviews and its analysis the most important. This focused investigation considers interview techniques developed with the Dooyeweerdian suite of modal aspects as foundation, namely MAKE (Winfield, 2000) and, MAIT (Kane, 2005) and is discussed in Chapter 7.

1.6.2.1 Research methodology

Action research is one of the qualitative “*strategies of inquiry*” used in this study (Myers, 1997). Two AR cycles are guided by literature and describe the introduction of technological instruments as focal points of instructional design, formative guidance, and summative assessment of repeating and newcomer students respectively. Each cycle anticipates an improved student experience, as well as learning to take place regarding the refinement of the derived HCI foci guiding the use of technological instruments. All AR cycles have the same aim, namely to enhance teaching and learning using different technologies while applied in different teaching phases. These AR cycles informs a subsequent anticipated AR cycle, and determines whether such a cycle is necessary.

Myers and Klein (2011:25) compiled the set of six principles to be used when conducting critical studies in IS; their summary of principles for critical research is adapted in Table 1.2. Each principle is applied to this study.

Table 1.2: Principles for conducting critical research as adopted from Myers and Klein (2011:25), applied to this study

No.	Principle		Principle explanation and motivation
1	Using core concepts from critical social theories	Elements of critique	Critical researchers should organise their data collection and analysis around core concepts and ideas from one or more critical social theorists. *In this study, with CST directing intervention, the work of Mishra and Koehler (2006), the work of Dooyeweerd (1969), along with that of Basden (2018), which is based on the Dooyeweerd philosophy, and a technique suggested by Churchman (1968), used in the diagnosis phase of AR in this study, are utilised.*
2	Taking a value position		Values such as open democracy, equal opportunity, or discursive ethics are advocated by critical theorists. These values drive principles 4 to 6. *In this study an important value position is that the learning taking place with regard to individual students cannot be connected to marks earned – with examination marks believed not to be a true reflection of knowledge acquired. Since the subject modules prepare students for a large number of potential job opportunities, the emphasis is on each student developing his or her full potential (Flood & Jackson, 1991:49). In some cases students will only realise its value long after completing the subject modules. This principle drives the latter three transformation principles.*
3	Revealing and challenging prevailing beliefs and social practices		Critical researchers should identify important beliefs and social practices and challenge them with potentially conflicting arguments and evidence. *Two applications incorporated in this study challenges important beliefs and social practices, namely the fact that the Dooyeweerdian philosophy is not generally applied in IS, and the HCI principles are not widely applied to MIMAs. The former is supported by Basden, who suggests five frameworks based on Dooyeweerd's philosophy – to be applied in IS. One of these, namely the AEF (Basden, 2008; Basden, 2018), is of value in this study. Another framework which guides the use of technology specifically in an educational context, the framework for TPACK interaction (Mishra & Koehler, 2006), is also considered in this study.*

No.	Principle		Principle explanation and motivation
4	Individual emancipation		Alvesson and Willmott (1992) argue that CST is oriented toward facilitating the realisation of human needs and potential, critical self-reflection, and associated self-transformation. *This study aims to emancipate the author as lecturer and researcher, the students enrolling for the subject modules, and the student assistants working with the lecturer. Since the focus is on the student, and with SA&D preparing students for a number of potential jobs on different levels, emancipation would occur in an environment allowing them to develop their potential to the fullest (Flood & Jackson, 1991:49).*
5	Improvements in society	Elements of transformation	It is suggested that improvements in society are possible. The goal is to *suggest* how unwarranted uses of power might be overcome, not just reveal the current forms of domination. Most critical theorists assume that social improvements are possible, but to different degrees. *Students who completed the subject modules may approach subsequent subject modules differently, and after completion of their BSc course, the attitude, knowledge and skills of students may direct their careers, while colleagues teaching IS modules to students who are busy with, or have completed these classes may be impacted as well.*
6	Improvements in social theories		Critical theorists believe that the theories are fallible and that improvements in social theories are possible, therefore critical researchers entertain the possibility of truth claims arising from alternative theoretical categories competing. This may guide critical researchers in their analysis and interventions. *In this study, Basden's AEF is applied in an educational environment. Since this has not been done before, new insights may come to the forefront.*

1.6.2.2 Data collection and analysis

In gathering data for the AR study on SA&D, and the selection of participants in each of the three focal points, the following are used as guidelines:

- In the subject modules of SA&D, data is collected from lecturer and student reflections, conversations with colleagues and peers, feedback instruments used from time to time in class, information gathered from the learning management system (LMS), and actual mobile instant messaging application (MIMA) conversations.
- An AR cycle is evaluated through the use of interviews with students who repeated the subject modules, to obtain a deeper understanding of the value of the three focal points. This is done while keeping in mind the derived HCI foci, as well as the framework for TPACK interaction.
- Aspectual reflection of the three focal points relies on content analysis (of the SMARTguides), brainstorming (Videos), and analysis of texts (WhatsApp conversations).
- An AR cycle gathers data through interviews once more, specifically the MAKE (Winfield, 2000). It is based on the suite of modal aspects developed by Dooyeweerd, and guided by the AEF developed by Basden.

In data analysis, the Hermeneutic Circle with its double hermeneutic reporting has a threefold effect: it is accepted that the assumptions made by the researcher will affect data gathering, since the questions asked will determine the answers of participants; analysing data affects the data, and the data affect its analysis as well; and the meaning of words used in the data need to be understood in the context of a particular interview.

The discussion of the empirical research to be conducted in this study is concluded. The limitations to conducting the study is addressed next.

1.6.3 Limitations to the study

In AR, the people (participants) working in the context of the study is expected to contribute to the identification of problems (diagnosing) that should be addressed in a specific cycle. They will also be expected to support the researcher in determining how to address the problems identified (planning for action), take part in the action (taking action), and support the decision regarding determining the value of the intervention (evaluation). In the educational context it may be necessary to amend such a scenario outside the interview milieu. In the case of this specific study only students who completed the subject modules would be targeted to be interviewed. Also, in this specific study students are not mature, and most of them do not have career experience, and therefore they struggle to identify problems and design solutions regarding how they should be taught. That is the domain of the lecturer who may draw on the analysis of data to make informed decisions about future developments in subject modules. In addition, in an educational context, problems are identified and an enhanced plan is compiled with a particular group of students doing the subject modules, while its implementation (taking action) will affect a new intake of students. When determining the value of an intervention, primarily a lecturer who offered the subject module(s) before and during the implementation of the intervention is in a position to make an evaluation judgement. This limitation to this study opens up an opportunity for the researcher to reflect on the application of AR in an educational context.

1.7 ETHICAL CONSIDERATIONS

Ethical considerations include placing the students enrolled in the subject modules offered in the centre of the study to ensure that they excel in their studies, especially where the AR cycles are concerned. Utmost care is taken to ensure that participation has no effect on the success of a student in the subject modules. Students participate of their own free will on the MIMA groups, in conversations with the lecturer, as well as in anonymous feedback techniques, and their choices are respected. Consent is obtained for the use of their communication with their lecturer on eFundi, the LMS of the university. Only candidates who have completed their course (alumni) are considered to be interviewed. Such candidates sign a consent form upon being interviewed. The research study is done with the anonymity of all the participants ensured. Ethical clearance was obtained for this study by the Research Committee of the Faculty of Economic Sciences and IT of the Vaal Campus of the North-West University; ECONIT-2016-108. It is important to note that students who completed the modules under investigation in this study, are not taught any follow-up modules in the IT course by the same lecturer.

1.8 CHAPTER CLASSIFICATION

This study will comprise the following chapters:

Chapter 2 discusses the research approach with the suggestion of a framework in the context of IS research. The organised use of rational thought; with reference to a framework of ideas, a methodology and an area of concern is suggested to guide the study.

Chapter 3 supplies the context of the study and introduces the three focal points of instructional design, formative guidance, and summative assessment.

Chapter 4 debates the inclusion of HCI principles found in literature in this study. It also investigates the framework for TPACK interaction as a model to support the extraction of HCI principles.

Chapter 5 implements an AR cycle in the context of SA&D teaching and learning. This cycle is informed by literature addressed in the preceding chapter – to improve the experience of repeating (R) students, and enable learning regarding the verification and refinement of the derived HCI foci.

Chapter 6 studies the philosophical framework used in this study as developed by Dooyeweerd, including his 15 modal aspects for understanding reality.

Chapter 7 investigates the AEF as enabler of analysis and sense-making of the derived HCI foci in the context of the Dooyeweerdian aspects. It also inquires the application of the Dooyeweerdian aspects in the context of the aspectual engagements as described by Andrew Basden. In this chapter its application manifests in the aspectual reflection of the derived HCI foci, and the three focal points of this research.

Chapter 8 implements a second AR cycle in the context of SA&D teaching and learning. This new cycle is informed by literature addressed in the preceding two chapters to improve the experience of newcomer (N) students, and enable learning regarding the verification and refinement of the HCI principles.

Chapter 9 reports on the consolidation of the results regarding the extraction of human computer guidelines from the two AR cycles discussed in Chapters 5 and 8.

Chapter 10 concludes the study in terms of extracting guidelines for the use of technology in higher education through the communication of the findings.

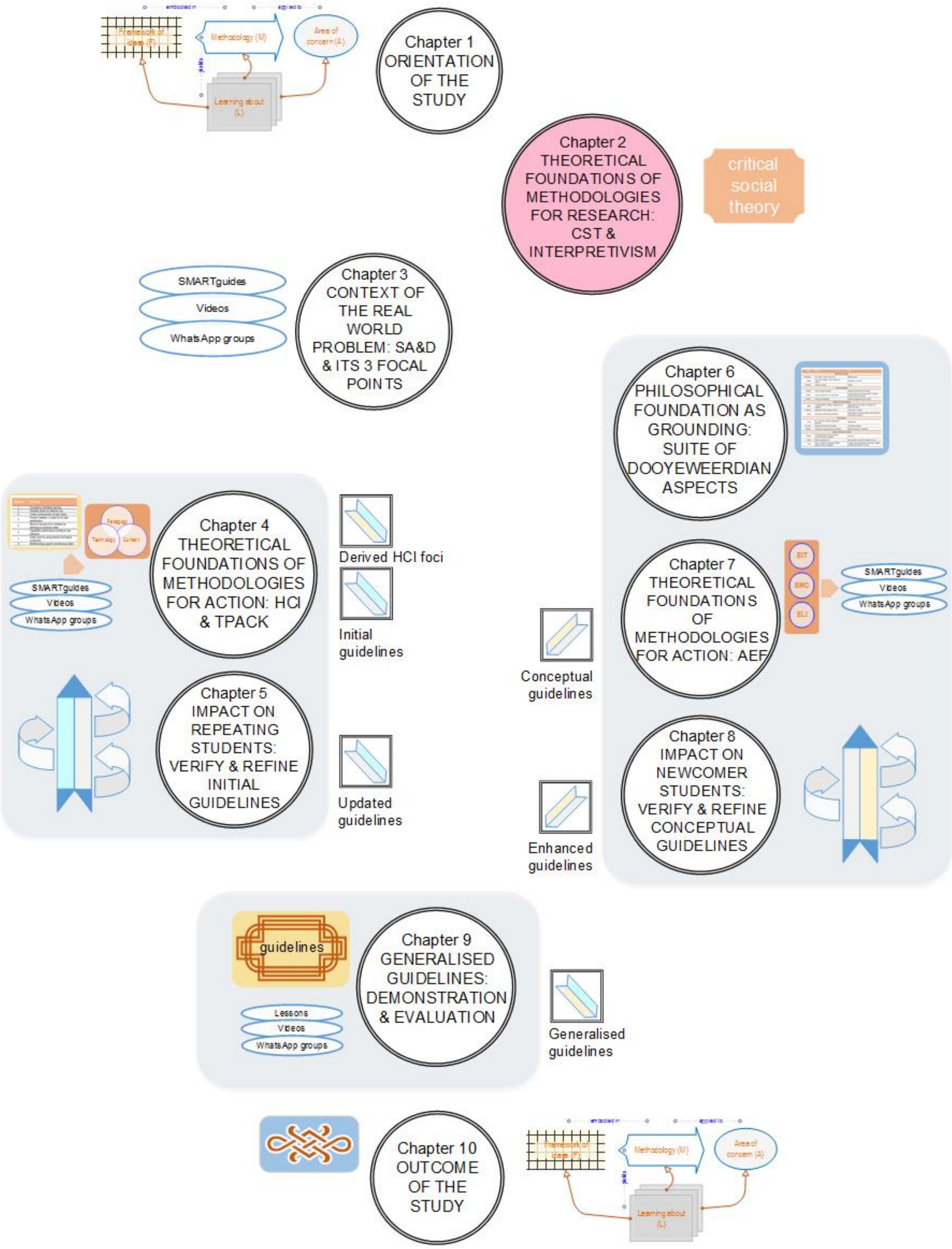
1.9 SUMMARY

The purpose of this study is to gain an understanding of the use of technology in higher education – to support the development of guidelines for the use of technology, based on an understanding of human use of computers and specifically existing HCI principles – from a Dooyeweerdian perspective.

This chapter focused the concepts key to this study, including the principles for guiding HCI, the framework for technological pedagogical content knowledge (Mishra & Koehler, 2006), the suite of modal aspects developed by Dooyeweerd (Dooyeweerd, 1969), which guides the use of technology in education in the context of the AEF (Basden, 2008; Basden, 2018), and the perspectives relevant to IS research. Understanding the key concepts to this study is followed by the problem statement which explained the educational context and the problems encountered in SA&D offered as subject modules in an IT course. The model by Checkland and Holwell (1998b:23), which was used to draw a research plan for this study, and aided the understanding of the elements relevant to this study, was introduced next. The primary objective of this study was stated, and broken down to its theoretical, reflective, and empirical foci. The research design, based on guidance from literature, was relayed to guide the implementation regarding this study. Ethical considerations for this study followed, and lastly the chapter breakdown for this study was listed.

The subsequent chapter introduces the research approach guiding this research project by providing the perspectives pertaining to IS research, and the corresponding research methodologies from which the applicable research design evolves.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



2 THEORETICAL FOUNDATIONS OF METHODOLOGIES FOR RESEARCH: CST & INTERPRETIVISM

2.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education based on human computer interaction principles from a Dooyeweerdian perspective.

In order to achieve this primary objective, this chapter addresses the first theoretical objective (T01), namely to understand critical social theory applied in a higher educational setting by means of action research on three focal points using the aspectual engagements framework grounded in the Dooyeweerdian philosophy.

In summary, this chapter develops and motivates a detailed research plan for this project. It covers the following topics, namely; the elements relevant to this study (§2.2) theory in information systems (§2.3), research paradigms (§2.4), research methodology (§2.5); research methods (§2.6), the research design guiding its execution (§2.7); and lastly a section concluding this chapter with a summary (§2.8).

2.2 ELEMENTS RELEVANT TO THIS STUDY

The model developed by Checkland and Holwell (1998b:23) as depicted in Figure 2.1, is used as reference to draw a research plan for this study and to aid the understanding of the research process.

Gregor (2006) investigates the nature of theory in information systems (IS). This theory underlies the IS research environment which implements research in mainly four paradigms, namely positivistic, interpretive, critical social theory (CST) and design science research (DSR). This chapter attempts to justify why particular paradigms are relevant to the study; why some are important, and others not applicable. Using the context of Figure 2.1, this chapter focuses on the intellectual framework (F) and specifically addresses the major role that CST plays, as well as the supporting role of interpretive research. Therefore, in addition to understanding the use of CST, it is imperative to also understand interpretive research as supportive paradigm to understand the study in its entirety.

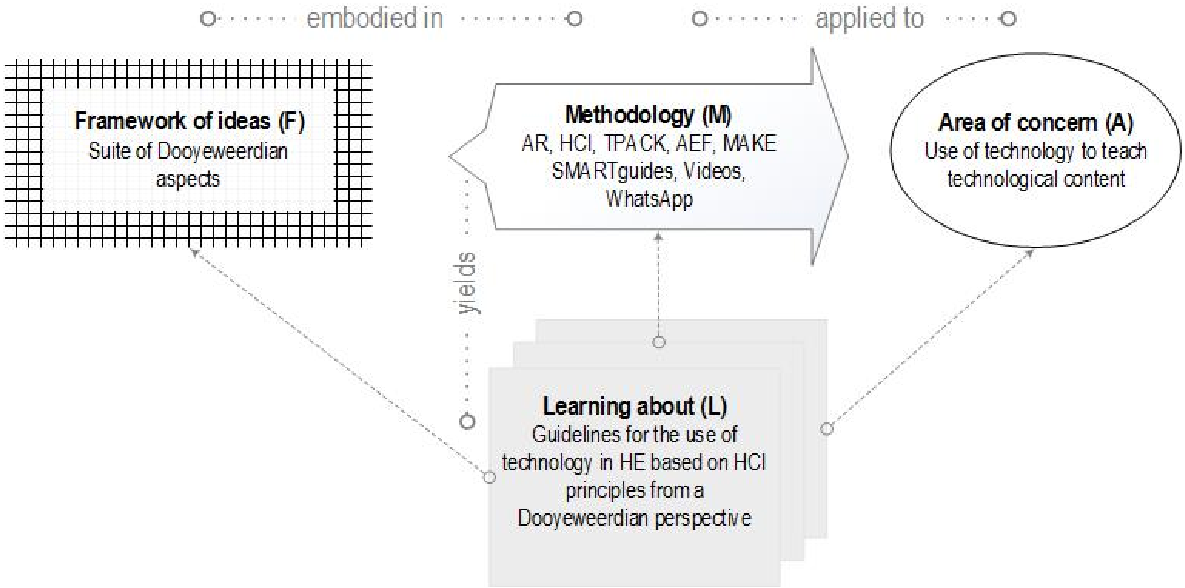


Figure 2.1: The elements relevant to this study

In a research project validity may be a point of contention. To address this issue and to ensure the validity of this research project, the methodology (M), represented by a set of principles are used to guide the research, namely the six principles for conducting critical research as compiled by Myers and Klein (2011), and to a lesser extent, the set of seven principles to be used when conducting and assessing the quality of interpretive field studies in IS, as compiled by Klein and Myers (1999).

The term methodology implies the use of methods. In this study, action research (AR) is utilised as a research method, as well as a qualitative strategy of inquiry (Creswell, 1998; Myers, 1997). This method is applied to the area of concern (A) – the subject modules of systems analysis and design (SA&D), offered in an educational setting. The two interview approaches based on Dooyeweerd's 15 modal aspects, namely multi-aspectual knowledge elicitation (MAKE) suggested by Winfield (2000), and multi-aspectual interview technique (MAIT) suggested by Kane (2005), are techniques investigated for the purpose to identify one to be used in support of the aspectual engagements framework (AEF) discussed in Chapter 7. As an extension to the methodologies relevant to the study, this chapter also explains how data collection and analysis methods are utilised in, and applied to this study.

As part of this chapter, the duality of the FMA model is addressed through the work of McKay and Marshall (2001) and Mathiassen *et al.* (2012). This discussion originates in AR and allows the AR practitioner to differentiate between the elements of frameworks, methodologies and areas of application for the purpose of reporting. In essence, the organisation of rational thought (Checkland & Holwell, 1998b), guides this research, while the elements (Mathiassen *et al.*, 2012; McKay & Marshall, 2001), extracted from this study directs the communication regarding its contribution. In Section 2.6.2.3, the refinement is investigated and the elements are applied to this study. This refined FMA model is then used in subsequent chapters.

2.3 THEORY IN IS

From a philosophical point of view, theory provides the grounding necessary to conduct research. The following sub-sections investigate the definition of theory, its classification, and lastly the relevance of theories relating to this study, is discussed.

2.3.1 Defining theory

Popper (1980:59) describes theory as "*linguistic representations*", and *"systems of signs and symbols"*. It is therefore man-made representations of our world, which continues to be improved and refined. He went on to explain that:

> *"Theories are nets cast to catch what we call 'the world'[1]; to rationalize, to explain and to master it. We endeavor[2] to make the mesh even finer and finer".*

Koskela (2000:18) suggests that the term theory may be replaced by terms like *paradigm* and *philosophy*, two terms also used in this study. Since the three terms are not absolute synonyms, they are explored in more depth. The paradigm concept is said by Kuhn (1996) to encompass more than that of a theory; it implies rules for conducting research, it specifies criteria by which to select problems – while a problem is assumed to have a solution. The Kuhn (1996) viewpoint is supported in this study and four paradigms, including positivistic, interpretive, CST and DSR are scrutinised to select the appropriate ones. The applicable paradigms are used as the driving force of the research and invoke the repertoire of methodologies, methods and techniques applicable to the study, making it applicable to a research setting. A philosophy implies that philosophical assumptions, including ontological, epistemological, axiological and methodological assumptions

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[1] The quoted words are included from Popper, but the double quotation symbol was replaced by the single quotation symbol to accommodate the double quotation symbol used for quotations in this study.

[2] The spelling of words in quoted phrases is kept according to the original text.

ground and constitute research (Myers, 1997). Philosophy therefore provides the grounding of paradigms.

2.3.2 Classification of theories

Rooke *et al.* (2009:915) suggest a classification of theories from a non-IS point of view, namely empirically driven, including ethnomethodology, ethnography, GT and participant AR; and theoretically driven constructive research. Gregor (2006:620) provides a similar classification, but specifically for IS theories, based on the primary goal of the theory, namely analysis, explanation, prediction, explanation and prediction, and design and action. Table 2.1 provides a summary of Gregor's classification.

Table 2.1: Theory types in IS (quoted from Gregor (2006:620))

Theory type	Distinguishing attributes
Analysis	Says what is. The theory does not extend beyond analysis and description. No causal relationship among phenomena is specified and no predictions are made.
Explanation	Says what it is, how, why, when and where. The theory provides explanations but does not aim to predict with any precision. There are no testable propositions.
Prediction	Says what is and what will be. The theory provides predictions and has testable propositions but does not have well developed justificatory causal explanations.
Explanation and prediction	Says what is, how, why, when, where, and what will be. (*It*) provides predictions and has both testable propositions and causal explanations.
Design and action	Says how to do something. The theory gives explicit prescriptions (e.g. methods, techniques, principles of form and function) for constructing an artefact.

From the above, two distinct categorisations may be identified, namely a descriptive one which "*describe(s), explain(s), and enhance(s) understanding*" (Gregor, 2006:616), and may be used to describe phenomena that occurred in the past; and a prescriptive one which "*provide(s) prediction(s)*" ... "*and give(s) a basis for intervention and action*" is used to direct future interventions.

With this, the discussion of theory is concluded and its focus is directed towards the four research paradigms pertaining to IS and the philosophical assumptions accompanying each.

2.4 RESEARCH PARADIGMS

Kuhn (1977:294) defines a paradigm as follows:

> *"A paradigm is what members of a scientific community, and they alone, share".*

Therefore, in science and epistemology (the theory of knowledge), a paradigm is a distinct concept or thought pattern. Koskela (2000:19) indicates that it is possible that paradigm shifts may occur, agreeing with Kuhn (1996), who states that theories may evolve, causing paradigmatic shifts, which is a change in the basic assumptions (which may be stated as paradigms), within the ruling science theory.

A number of publications have argued for using different paradigms for different types of IS research. Initially the debate was focused on quantitative and qualitative methods (Myers, 1997). This evolved from the logical positivist viewpoint that originated in Europe just after World War I (Gregor, 2006:615) and relied on quantitative data as opposed to the interpretive approach which relied on qualitative data (Orlikowski & Baroudi, 1991:5). It is important to heed the warning of Klein and Myers (1999:69) that in many cases researchers do not differentiate between qualitative and interpretive research, as they are not synonyms. Myers (1997) posits that *"qualitative research may or may not be interpretive, depending upon the underlying philosophical assumptions of the researcher"*, which means that when using the positive-interpretive-critical classification of research epistemologies suggested by Chua (1986), qualitative research can be done from any of these stances.

Mingers (2001) had an argument for pluralism in methods and Lee (2001) for the integration of approaches. These mixed methods allow both quantitative and qualitative methods and data to be used in one research study. Critical social theory, which addresses moral and ethical issues while seeking to emancipate humans, was added to the repertoire of IS paradigms (Ngwenyama & Lee, 1997; Orlikowski & Baroudi, 1991).

Although people such as Myers (1997) does not include design science as a research paradigm, DSR, especially in IS, recently received much attention (Gregor & Hevner, 2013). Since Information Systems is distinguished from other fields because it uses artefacts in systems where humans interacts with machines; IS studies more than a technological system, or a social system, it researches the phenomena emerging where the technology and the social systems interact (Lee, 2001:iii). This necessitates theory linking the natural, social and artificial world of human creation (Gregor, 2006:613). For this reason Simon (1996), Hevner *et al.* (2004) and Vaishnavi and Kuechler (2004) argues for a paradigm that uses natural, social and design science. In his editorial on "*What design science is not*", Baskerville (2008:442) categorises design science as a paradigm rather than a methodology. Iivari (2007) contributes to this debate by analysing design science paradigmatically; suggesting the ontology, epistemology, methodology and ethics of design science. In the same article Iivari (2007), and later Iivari and Venable (2009) distinguish between design science and AR to take the argument for design science being a paradigm further. Winter (2008), and Winter *et al.* (2007) contributed to the debate for a design science paradigm by looking at its relevance and rigour. This debate supports a fourth paradigm. Although the debate is on-going, design science is included in this research as a paradigm to support the various aspects of the research.

Throughout the abovementioned development, various researchers argued for *"methodological pluralism" (Baskerville & Wood-Harper, 1996)* or "*multimethodology*" (Mingers & Brocklesby, 1997) – to ensure that a variety of problems may be addressed using a combination of individual approaches. Morgan (1980) and Hirschheim (1985:32) posited for the existence of many methods of science as opposed to only one correct method. Applying their argument, one would select the correct method in line with the problem being researched, according to the *"kind of knowledge desired"* (Hirschheim, 1985:32). Gregor (2006:612) agrees and also reasons for varied research approaches, each adopted according to *"different types of theory in IS"*.

The four main paradigms in IS research, namely that of positivism, interpretivism, CST and DSR (Blanche *et al.*, 2006:6) are discussed below; each with its underlying metaphysical assumptions; namely that of ontology, epistemology, axiology and the methodology with the corresponding data gathering and analysis techniques. Through discussing the metaphysical assumptions, the terminology associated with each paradigm, is elucidated. To clarify the discussions of the metaphysical assumptions that follow, the following explanations are important:

- *Ontological assumptions* comes from the nature of being and how that may be categorised, it verbalises existence and focuses on the researcher's view of reality or the worlds we live in (Midgley, 2000; Myers, 1997).

- *Epistemological assumptions* sets the criteria used to construct and evaluate valid knowledge about a phenomenon (Orlikowski & Baroudi, 1991:8); it looks into the nature of knowledge and how knowledge relates to truth, our beliefs and how we justify knowledge (Myers, 1997).
- *Axiological assumptions* take the aspects the researcher believes to be of value regarding the study, into consideration (Myers, 1997).
- *Methodological assumptions* state the validation principles applicable to each paradigm, as well as the research methods available to use. Midgley (2000:105) distinguishes between a *methodology* and a *method*, where the former is "*a set of techniques operated in sequence (or sometimes iteratively) to achieve a given purpose*" and the latter is "*a set of theoretical ideas that justifies the use of a particular method or methods*". Based on this distinction, both the validation principles and the research methods applicable to a research paradigm, are included.

Basden (2008:16) forms questions related to each assumption category listed above – which is particularly helpful in distinguishing between the different metaphysical assumptions and also to assist a researcher in understanding a study, and then to verbalise such understanding:

- *Ontology*: what does the world in which the people in the study work, look like?
- *Epistemology*: how do we learn to know our domain? What is good research? How would one form a good theory or conceptual structures?
- *Axiology*: what is problematic in the domain under investigation, and what may be aspired to? What would the primal motivation for the study be?
- *Methodology*: how do we ensure rigour in our research? Which methods should be used in a study?

To support the five categories listed for each of the four paradigms as discussed in the rest of this section, Figure 2.2 provides a visual summary of the four research layers; namely the IS paradigms, its corresponding philosophies and examples of associated methodology and practice examples according to the author's understanding.

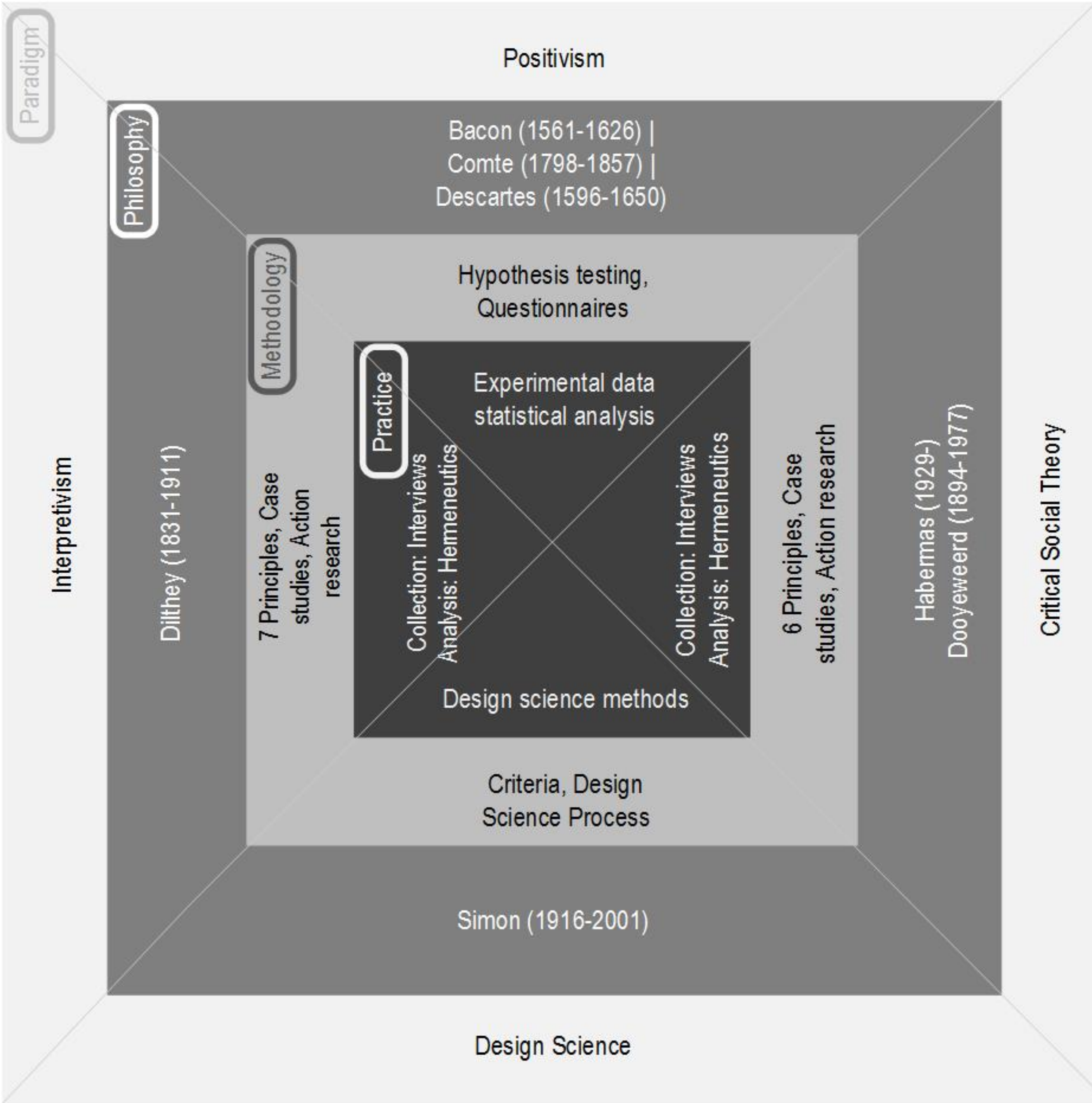


Figure 2.2: A visual representation of the research layers

In the subsequent sub-sections, each paradigm is discussed chronologically using the following prompts; the paradigms as it would be applied across disciplines, its application in IS, the metaphysical assumptions, and how data is collected and analysed. In Section 2.4.5, this discussion culminates in a debate on how each paradigm may or may not be relevant to this research project.

2.4.1 Positivism

According to Straub *et al.* (2004), *positivists* work from the assumption that the world is ordered and regular, not random. Therefore, one should investigate it objectively to summarise observations in order to find universal laws and patterns. In many cases structured instrumentation is used to investigate phenomena (Orlikowski & Baroudi, 1991:5) and therefore proof and measurement are important. Often a theory is tested. Midgley (2000:24) warns "*that one can never be absolutely sure about the extent to which knowledge is accurately reflecting knowledge*". This is in accordance with the argument of Popper (1980) that we cannot prove a theory, we can only falsify it. Truth is an ideal, something to strive towards. Popper's conclusion is that our knowledge is imperfect and certainty is not possible, at best we can refine our knowledge by continuing to question what we know.

Research in Information Systems is classified as positivist in the following situations; there is a manifestation of formal suggestions, variables can be measured quantitatively, a hypothesis can be tested, or inferences can be drawn from a sample of a population to the full population regarding a phenomenon (Orlikowski & Baroudi, 1991:5).

The metaphysical assumptions of positivism include the following:

- *Ontological assumption*: Myers (1997) describes reality from a positivist perspective as something that can be viewed in an objective way, therefore we can describe it by measurable properties; independent of humans and the instruments used.
- *Epistemological assumption*: in positivist studies theory is primarily tested, with this an attempt is made to improve a phenomena's predictive understanding (Orlikowski & Baroudi, 1991:5). Chua (1986:604) posits that the positivist world view requires empirical events to repeatedly not falsify a theory, for the theory to be considered true.
- *Axiological assumption*: according to Myers (1997) truth and conviction is paramount for the positivist.
- *Methodological assumption*: in the quest for validation of positivistic studies in IS, Straub *et al.* (2004) contributed by offering research heuristics via content validity, construct validity, reliability, manipulation validity, and statistical conclusion validity. Orlikowski and Baroudi (1991:8) consider large-scale sample surveys and controlled laboratory experiments as suitable positivist research methods since they allow the manipulation of parameters and statistical operations with the corresponding required control over the data when collected and analysed.

Data gathering is done through formal methods such as statistical and mathematical theories; numerical methods such as mathematical modelling and simulations are also utilised (Goddard & Melville, 2004:51). Data generated through the mentioned methods are analysed using statistical measures including calculations and graphical presentations (Goddard & Melville, 2004:51). In some cases a hypothesis is formulated, and after analysis of the data the hypothesis may be accepted or rejected.

2.4.2 Interpretivism

For the *interpretivist*, the world is perceived as a social setting with people who have multiple views (Myers, 1997). It is important to make sense of reality and form a rich understanding. A theory or framework for understanding is developed. Denzin and Lincoln (2005) state that interpretive research places the emphasis on processes and meanings which are not examined in a rigorous way and is not measured in terms of quantity, amount, intensity or frequency. The interpretive researcher would rather be interested in gaining insight, and making discoveries and interpretations (Merriam, 1988) through the symbols, norms and values that represent the world of participants (Remler & Van Ryzin, 2014:51).

Research in Information Systems is classified as interpretive when an attempt is made to understand phenomena through the meaning people attach to it (Myers, 1997). This means the world is seen as subjective, it therefore exists only through the action of people who create and recreate it (Orlikowski & Baroudi, 1991:7). Walsham (1993:4) goes further to describe interpretive research in IS as follows:

> *"(it is) aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by its context*".

This allows the researcher to understand a situation from its cultural and contextual perspective and to form a deeper realisation of the structure of a phenomenon – studied in its natural environment to understand the view of the participants; without imposing the researcher's understanding on the situation (Orlikowski & Baroudi, 1991:5).

The metaphysical assumptions of interpretivism include the following:

- *Ontological assumption*: Walsham (1993:5) describes reality from an interpretivist's point of view as socially constructed by people; for this reason there is no objective reality to be discovered by a researcher that may be replicated by others at a later stage. Rather than objectivity, interpretive studies focus on how people form their own subjective and inter-subjective meanings as they function in their world (Orlikowski &

Baroudi, 1991:5), through the social constructions of "*language, consciousness and shared meanings, documents, tools, and other artifacts*" (Klein & Myers, 1999:69). An interpretive researcher aims to understand a phenomenon by studying the meanings participants associate with it, objectivity or a factual account of a situation is not the intention (Orlikowski & Baroudi, 1991:5).

- *Epistemological assumption*: interpretive studies generally attempt to understand phenomena through the meanings that people assign to them (Myers, 1997); knowledge is subjective because it is socially constructed (Walsham, 1993:5).
- *Axiological assumption*: the contextual understanding drives interpretive research (Walsham, 1993:5). The social structures formed in the minds of participants involved in a system such as users, analysts, designers, and developers; or in the educational setting the lecturer, students, and assistants form part of a contextual structure (Walsham, 1993:5).
- *Methodological assumption*: the paper by Klein and Myers (1999) suggests a set of seven principles to guide and evaluate interpretive research. It includes the *hermeneutic circle*, *contextualization*, *interaction* between the researcher and the subjects, *abstraction* and *generalisation*, *dialogical reasoning*, *multiple interpretations*, and lastly *suspicion*. Research methods include AR, case study research, ethnography and GT, also called qualitative strategies of inquiry (Myers, 1997).

Data is collected using a number of techniques such as interviews, participant observation (fieldwork), and using documents (Myers, 2013). Myers (1997) argues that positivists clearly differentiate between gathering data and analysing it, while this is not true for interpretivists since a researcher's presuppositions is assumed to affect data collection. For this reason modes of analysis is a more accurate reference than data analysis. Modes of analysis include hermeneutics, semiotics, and narrative or metaphor analysis.

2.4.3 CST

The *critical social theorist* is concerned with identifying the power relation, conflicts and contradictions existing in the situation and the empowerment of people to enable emancipation on a social, cultural or political level (Myers, 1997). It aims to critique the current state of affairs in order to change estranging and suppressive social constrictions deeply embedded in social systems (Orlikowski & Baroudi, 1991:5). A social reality is created and recreated by the people functioning within the social context. The critical researcher is interested in the interaction between people and the process that it represents (Creswell, 2003:9). The aim is to remove unfairness. It relies on three elements (Alvesson & Deetz, 2000:17), namely; *insight* – aiming to highlight less apparent facets of a reality in the process of interpretation, *critique* – challenging self-evident beliefs and assumptions that penetrate IS phenomena; this is a step beyond interpretation which aims to identify power structures, and *transformation* – improving human conditions through armament of applicable knowledge and a pragmatic understanding of the context (Richardson & Howcroft, 2006:145). Myers and Klein (2011:22) identify three major CST streams, namely that of Bourdieu as used in ethnographic studies, Foucault as used in historic studies and Habermas as the theory of communicative action. They allow for other less-known theories and encouraged the introduction of new authors such as Dooyeweerd into CST (Myers & Klein, 2011:21).

Research in Information Systems is classified as critical when it is evident that a critical position towards assumptions that people take for granted regarding organisations and IS are taken; this is done through dialectical analysis in an attempt to reveal the contradictory nature of existing social practices in use (Orlikowski & Baroudi, 1991:6). Klein and Myers (1999:69) claim that critical social theorists presume that people will wittingly work towards improving their social and economic situation, but they acknowledge that this ability may be impaired by limited resources, power structures and natural laws. For this reason critical researchers are focused on identifying alternative options that may emancipate individuals (Ngwenyama, 1991:268). He adds that CST build on five key assumptions, namely; methods should focus on practice and enable change, it should enhance enquiry into organisational processes and social context, sensitivity towards the organisation’s and the individual’s needs are important, collaboration should be supported to allow participants to be open and contribute freely, and critical self-reflection should be included (Ngwenyama, 1991:268).

Therefore, in the IS context, critical researchers believe that their presence influence the social and technological systems they study and vice versa (Ngwenyama & Lee, 1997:151). In addition, they postulate that observing people differs from observing nature, and that the social context of actors provide the basis for understanding, also, a researcher’s responsibility is not limited to provide explanations to facilitate understanding

– it should extend to formulate critique against unjust situations, constraints, assumptions or beliefs – to make provision for emancipation (Ngwenyama & Lee, 1997:151).

The metaphysical assumptions of CST include the following:

- *Ontological assumption*: social reality is established through history where it is developed and reproduced by people (Myers, 1997) and people have a constrained capability to enable change, therefore critical researchers should create an awareness of social domination to help people in the situation to obviate them (Orlikowski & Baroudi, 1991:19).
- *Epistemological assumption*: the main aim of critical research is that of social critique, through which possible restrictive conditions of the situation are highlighted (Myers, 1997); this knowledge may emancipate people through the development of their potential to its fullest (Flood & Jackson, 1991:49).
- *Axiological assumption*: enquiry is value-bound and contextual understanding is important – the researcher's values affect the study (Myers, 1997).
- *Methodological assumption*: the paper by Myers and Klein (2011) suggests a set of six principles to guide and evaluate critical research. It includes using *core concepts* from *critical social theories*, taking a *value position*, revealing and *challenging prevailing beliefs* and social practices, individual *emancipation*, *improvements in society* and lastly, improvements in social *theories*. Ngwenyama (1991:272) claims that CST uses similar methods to that of interpretative research, such as AR, case study research, ethnography and GT (Myers, 1997), but it should be adapted to its needs. It is paramount that its requirements, which links to the five key assumptions listed earlier, are adhered to.

Data is collected using the techniques listed for interpretive research, namely interviews, participant observation and fieldwork, and documents (Myers, 2013). Similarly, modes of analysis are the same as that interpretivists use, namely hermeneutics, semiotics, and narrative or metaphor analysis (Myers, 1997).

2.4.4 DSR

Simon (1996:4), who is seen as the father of this paradigm, distinguishes between positivism, or natural science and science of the artificial, or design science. March and Smith (1995:253) add to this argument by stating that natural science theorises and justifies, while design science builds and evaluates. The first is a body of knowledge about objects or a phenomenon occurring in the world – it describes how they behave and interact, while the latter is a body of knowledge about man-made objects or phenomena designed to meet set goals (Vaishnavi & Kuechler, 2015:9). Design science has its origination in the engineering discipline (Peffers *et al.*, 2008:47; Simon, 1996) and it seeks to solve problems from a fundamental point of view Hevner *et al.* (2004:76). March and Smith (1995:255) identify four design science elements, including *constructs* which are concepts that characterise a phenomenon, *models* which describe tasks, situations, or artefacts, *methods* which direct how activities toward a goal should be carried out, and *instantiations* that represent the physical implementation of an artefact in its environment.

With the above in mind, Hevner *et al.* (2004:76) classify the *design scientist* in IS as a problem solver; the creator of innovative solutions, resulting in products, ideas, practices or technical capabilities. With Gregor and Hevner (2013:337) arguing for the acceptance of DSR as a legitimate paradigm in IS research, the metaphysical assumptions are discussed.

The metaphysical assumptions of design scientists include the following:

- *Ontological assumption*: multiple world-states exist, depending on the context, but "*the multiple world-states of the design researcher are not the same as the multiple realities of the interpretive researcher: many if not most design researchers believe in a single, stable underlying physical reality that constrains the multiplicity of world-states*", with the introduction of novel artefacts which change the state-of-the-world (Vaishnavi & Kuechler, 2004). Therefore the design scientist aims to manipulate and control the environment creatively (Vaishnavi & Kuechler, 2004).
- *Epistemological assumption*: information is seen as factual and it has meaning through the process of construction. With the construction of an artefact its behaviour is the result of interactions between components of the composite system – the artefact and its user, with its meaning the usefulness thus enabled (Vaishnavi & Kuechler, 2004).
- *Axiological assumption*: creative manipulation and control of the environment is the value that is of essence, rather than what understanding is for the interpretivist, and truth is to positivist.
- *Methodological assumption*: in the literature on DSR, the methodology (to evaluate) and methods (to guide) are in many cases intertwined. Gregor and Hevner (2013:351)

build on the work of earlier publications when they debate the *evaluation* of an artefact, the fifth step in their six-step DSR process suggestion (Hevner *et al.*, 2004; March & Smith, 1995; Peffers *et al.*, 2008; Vaishnavi & Kuechler, 2004) to include four criteria by which an artefact may be evaluated, namely *validity*, *utility*, *quality*, and *efficacy*. They elaborate on their statement by arguing that the criteria may or may not be applied, depending on the context which determines the rigour of the evaluation (Gregor & Hevner, 2013:351). Gregor and Hevner (2013:351) deem it important to supply evidence of an artefact's worth, examples being an expert review, simulation(s), and statistics on its usage where the evidence allow for flexibility regarding the degree of evaluation, for example in the case of a novel artefact, a proof-of-concept may be sufficient. Gregor and Hevner (2013:342) built on the work of others (Hevner *et al.*, 2004; March & Smith, 1995; Peffers *et al.*, 2008; Vaishnavi & Kuechler, 2004) to include the following six guidelines for artefact development; *identify* the problem, *define* solution objectives, *design and develop* the solution, *demonstration* of the solution, its *evaluation*, and then *communicating* it to the design community.

Data gathering and analysis techniques: Gregor and Hevner (2013:351) indicate that a range of techniques, qualitative and/or quantitative in nature (Hevner *et al.*, 2004:77), are at the disposal of the design science researcher when doing a rigorous design justification of an artefact. Hevner *et al.* (2004:77) suggest quantitative techniques which include optimization proofs, analytical simulation, and quantitative comparisons, as well as qualitative ones such as field studies and case studies. Carlsson (2010:209) also includes critical techniques such as heuristic design propositions, design patterns, models, frameworks and narratives.

2.4.5 Research paradigms relevant to this study

In the above sub-sections, the four paradigms believed to be of relevance to a study conducted in IS, namely positivism, interpretivism, CST, and DSR, have been discussed. The evolution of the paradigms was investigated, the main aim of each paradigm stated, the focus as applied in an IS environment highlighted, and the metaphysical assumptions applicable to each was posited. Before studying the methodologies applicable to this study in more depth, the relevance of each paradigm is discussed from a holistic point of view. The order of the discussion is adjusted to suit the argument.

Positivistic research starts out with a theory about a phenomenon. From this a hypothesis may be formulated to be tested using measuring instruments with the purpose of objectively and quantitatively falsifying the hypothesis. With the purpose of this research being developing guidelines for the use of technology in higher education, based on human computer interaction (HCI) principles – from a Dooyeweerdian perspective, the phenomenon of using technology in higher education is studied. One may elect to use an instrument of measurement in order to quantify the application of HCI principles – at the risk of not allowing the subjective voices of the students to be heard. To find out how well students find the teaching of content, one needs to ask the students. Each student will have her or his own view resulting in understanding the phenomenon multi-perspectival, hence no one answer or finding can be invalid, or valid in itself. The researcher as lecturer forms part of the study and aims to describe and understand the phenomenon. It is therefore clear that positivism does not support the goal of this study, since the ontology of positivism is grounded in objectivity – with it expecting the researcher being independent; epistemologically it attempts to investigate a phenomenon to discover one single truth and thus cannot address the phenomenon being studied in an adequate way.

Interpretive research enables the researcher to form a contextual understanding of a situation and it allows the gaining of deep knowledge of a phenomenon's structure – by hearing the views of the participants. Again, with the purpose of this research being developing guidelines for the use of technology in higher education, based on HCI principles – from a Dooyeweerdian perspective, the phenomenon of using technology in higher education is studied. Interpretivism addresses the purpose of this study with regard to the metaphysical assumptions. The prevalent ontological reality is one that is socially constructed by the students and lecturer, and it is not possible to replicate the exact study at a later stage. To determine the success of the teaching of content, one needs to ask the students, with each individual student having a unique view. Epistemologically, because of the fact that interpretive knowledge is socially constructed, its nature is subjective, and the understanding of a multi-perspectival phenomenon is its aim. Axiologically, the context of the educational environment guides the study.

Throughout this study the critical perspective is supported by interpretivism, with the aspiration of the researcher to understand the perspective of the students as participants. This understanding is pursued across all 15 modal aspects employed by the AEF, which is based on the philosophy of Dooyeweerd. In addition, data analysis is done from an interpretive perspective.

Critical researchers start with the assumption that reality is incomplete and skew, induced by power relations causing conflicts and contradictions which is not serving a community optimally. With the goal of this research being to develop guidelines based on HCI principles from a Dooyeweerdian perspective, the over-arching study of the SA&D subject modules utilises AR cycles of implementation in an attempt to *understand* the situation, with the focus on hidden aspects of the reality of student life, then *critically* identify debilitating structures, suppositions and beliefs – to enable transformation that will emancipate students to grow to their full potential. Firstly, this may be achieved through the improvement of the offering of the curriculum, along with the individual constructs utilised to guide and support students. Secondly a theory is formed through the development of HCI guidelines. The latter AR cycles employ the aspectual engagement framework to direct the focus to issues of power and change, as well as a broader perspective on issues pertaining to human activity, including communication, interaction with the artefact, socialising, and playfulness (Breems, 2014:31). From an axiological point of view, context is important and the researcher's value position influence the research.

Design science researchers start with the assumption that multiple realities exist which may be controlled and shaped through the creative development of artefacts – a value which is most important to design scientists. Epistemologically the design scientist sees information as factual, but it only has meaning when constructed. The goal of this research is the development of guidelines based on HCI principles from a Dooyeweerdian perspective, and although the instructional design of the SMARTguide utilised as interactive learning guide which forms part of one of the focal points used in the research, it is a means to an end, and not an end in itself.

With the research paradigms discussed, the focus is moved to the research methodology applicable to this study, discussed in order of importance.

2.5 RESEARCH METHODOLOGY

Midgley (2000:1) provides a useful explanation for a *methodology*, it is *"a theory about the valid and/or legitimate use of methods"*. To accommodate his distinction between *method* and *methodology'* (Midgley, 2000:105), this section discusses the latter, while the former is discussed in the next section. Addressing *methodology*, Lee *et al.* (1995:367) invite a discussion to enable the compilation of explicit criteria to review qualitative, case study and interpretive research in IS. Such a set of criteria would have the purpose of ensuring high quality interpretive IS research. Klein and Myers (1999) answer this call when they compile a set of seven principles. Later on they did the same for CST (Myers & Klein, 2011). In their latter paper they cautioned against applying their principles in a mechanistic way; they used the word "*principles*" to emphasize the fact that they are not "*narrowly defined criteria*", that might inform critical IS research (Myers & Klein, 2011:18). According to its importance in this study, the discussion starts with the set of six principles guiding CST, then the set of seven principles guiding interpretive research. The application of each principle to this study is discussed with the meaning of each. With the axiology of a CST study being value-bound, the value position guided by the work of Ulrich is addressed in Section 2.5.3.

2.5.1 Principles for critical research

Myers and Klein (2011:18), compiled a set of six principles to raise awareness and increase legitimacy with regards to critical research in IS. The article covers a number of issues, namely addressing what critical research is, guiding how to conduct critical research, distinguishing it from interpretive research, highlighting its significance and value, and guiding the assessment of the quality of a critical study. It is noted that these suggested principles are applicable to three types of studies, it includes studies with concepts from the work of Habermas, Bourdieu, and that of Foucault (Myers & Klein, 2011:19). The Bourdieu stream gives prominence to an asymmetric dispersion of symbolic and social assets, causing a discriminatory rift between the "*haves"* and "*have nots"* (Myers & Klein, 2011:21). The Foucault stream suggests the provision of tools to allow the self-emancipation of individuals by shedding light on unwritten rules of the system they function in (Myers & Klein, 2011:21). It is discursive in nature. The Habermas stream of communicative action suggests that mutual understanding among participants achieves emancipation by overcoming imperfections in communication (Myers & Klein, 2011:23). It is important to reiterate their encouragement of the introduction of new authors such as Dooyeweerd, with his less-known theory, into CST to diversify the philosophical grounding of the paradigm (Myers & Klein, 2011:21).

Also, this set of principles are concerned with the elements of *critique* (principle 1, 2 and 3), and *transformation* (principle 4, 5 and 6) and should be used in conjunction with the set of seven interpretive principles applicable to an element of insight. Myers and Klein (2011:25) provide a summary of principles for critical research in table format. These are adapted in Table 2.2, listed before the discussion of the six principles.

Table 2.2: Principles for conducting critical research as adopted from Myers and Klein (2011:25)

No.	Principle		Explanation of principle
1	Using core concepts from critical social theories	Elements of critique	Critical researchers should organise their data collection and analysis around core concepts and ideas from one or more critical social theorists.
2	Taking a value position		Values such as open democracy, equal opportunity, or discursive ethics are advocated by critical theorists. These values drive principles 4 to 6.
3	Revealing and challenging prevailing beliefs and social practices		Critical researchers should identify important beliefs and social practices and challenge them with potentially conflicting arguments and evidence.
4	Individual emancipation	Elements of transformation	Alvesson and Willmott (1992) argue that CST is oriented toward facilitating the realisation of human needs and potential, critical self-reflection, and associated self-transformation.
5	Improvements in society		It is suggested that improvements in society are possible. The goal is to *suggest* how unwarranted uses of power might be overcome, not just reveal the current forms of domination. Most critical theorists assume that social improvements are possible, to different degrees.
6	Improvements in social theories		Critical theorists believe that the theories are fallible and that improvements in social theories are possible, therefore critical researchers entertain the possibility of truth claims arising from alternative theoretical categories competing. This may guide critical researchers in their analysis and interventions.

A discussion of the principles follows subsequently.

2.5.1.1 Principle 1: using core concepts from critical social theories

The collection of data and its analysis should be organised around the ideas from critical social theorist(s). The suite of modal aspects which is part of Dooyeweerd's CST (Myers & Klein, 2011:21), along with the work of Basden (Basden, 2008; Basden, 2018), the AEF, which is based on that of Dooyeweerd, are used to structure the HCI principles acquired from literature – in the educational context of this study. The AR method applied to this study is using a technique suggested by Churchman (1968:28), also a critical social theorist, to structure the first phase of diagnosis. These structures enable a comparison with the analysed narratives obtained from interviews and observations which allows assumptions prevalent in IS phenomena to be challenged; a step beyond mere insight which aspires to discover power structures.

2.5.1.2 Principle 2: taking a value position

It is important for the researcher to take a value position, since it impels the principles pertaining to transformation. Flood and Jackson (1991:49), from the perspective of critical systems thinking, views the emancipation of individuals in society so as to create circumstances in which they may achieve "*the maximum development of their potential*". Therefore, a strong value position taken in this study, is that marks earned in the final examinations of the subject modules are not directly reflecting knowledge acquired by an individual. Thus, it makes sense to value all learning taking place, since it may support subsequent learning to be acquired later in the course, as well as learning in a future occupational environment. In many cases learning is focused on what students perceive themselves excelling in.

The 15 modal aspects which is part of Dooyeweerd's CST (Myers & Klein, 2011:26), are used to guide its value position. In support, it may be useful to refer to the ontological question formulated by Basden (2008:16), namely: "*What is the nature of the world with which those who work in the area engage?*". Answering this question highlights another value relevant to this research; namely that technology may be useful in teaching technology content. Students are digital natives and use technology as an extension of themselves, for this reason it may be useful to use the same technology to guide their learning (Jones *et al.*, 2010; Thompson, 2013).

Lastly, Dooyeweerd's CST is based on Christian values and although this is not the point of departure for this research, the researcher lives these values and sees lecturing not as an occupation, but a calling affording an opportunity to make a life-long impact on the students studying SA&D as subject modules.

It is anticipated that the repeating (R) group of students (Chapter 5, AR Cycle R) will be affected more than the newcomer students (N) (Chapter 8, AR Cycle N), and therefore is chosen as the subject of the first AR cycle interviewed.

2.5.1.3 Principle 3: revealing and challenging prevailing beliefs and social practices

For critical researchers it is crucial to state important beliefs and social practices which may be challenged with evidence which is conflicting in nature. Two important beliefs which may be challenged in this study are: the philosophy of Dooyeweerd is not widely applied in IS, and HCI principles are rarely applied to mobile instant messaging applications (MIMAs). Basden supports the former challenge, when he suggests five frameworks based on Dooyeweerd's philosophy – to be applied in IS, of which one, namely the AEF, may be of value. Another framework which guides the use of technology specifically in an educational context – with similarities to the AEF, namely the framework for TPACK interaction is also reflected on.

In a complex environment, a number of beliefs and practices may be challenged. From an education point of view, teaching through the use of age-old methods to youngsters who are used to finding information though electronic means (Waycott *et al.*, 2010), may be challenged. When teaching technology content, this notion is even more important than when teaching other content. Here, the Dooyeweerdian suite of modal aspects may direct attention towards habits people may have, traditions they follow, and rules they apply with the purpose of criticising it (Myers & Klein, 2011:27).

2.5.1.4 Principle 4: individual emancipation

In CST, it is important to allow the emancipation of each individual participating – the student enrolled for the subject modules, the author as lecturer and researcher, and senior students supporting the students in the class, through self-reflection and self-emancipation to unlock human potential (Alvesson & Willmott, 1992). Flood and Jackson (1991:49) posit that the emancipatory focus should be on establishing a learning milieu conducive to developing the full potential of participants. When preparing people for their future career in an environment that is constantly changing, it is important to realise their potential and transform them into life-long learners (Spagnoletti *et al.*, 2013).

In an educational setting such as the one this study focuses on, it is hoped that learning will prepare students for a large variety of occupations, on different levels of seniority, and that they will even be able to use the concepts studied in SA&D in careers outside the IS field of expertise.

2.5.1.5 Principle 5: improvements within society

It is important to expand thinking to broader than the research question, towards improvements in society at large. Not only current forms of domination should be identified, but also future uses of power. Within the university context, students may approach subsequent subject modules differently after completing the SA&D subject modules, and colleagues teaching subject modules to students while busy with these classes and/or after its completion may be impacted as well.

Upon completion of their BSc course, the emancipation of young adults regarding attitude, knowledge and skills may direct their career upon entering the business market in South Africa, which may have an impact on overcoming current forms of domination. In South Africa, where a high unemployment rate prevails, candidates finding employment in the IS market will impact society in terms of their contribution, as well as the fact that they are educated in a technological field (Rasool *et al.*, 2012), well-suited in the age of information and knowledge, prevalent to the current work environment (Drucker, 1995).

2.5.1.6 Principle 6: improvements to social theories

With CST being critical in essence, this principle reverts back to the first principle where the researcher is expected to use core concepts from critical social theories. Critical theorists believe that these theories are fallible and therefore it would be possible to improve these theories or its implementation; this critique extends to a researcher's value base (Myers & Klein, 2011:28). In this study, the AEF, based on the suite of Dooyeweerdian modal aspects, and developed by Basden, is applied in an educational setting. New insights may come to the fore since this is a rare application.

2.5.2 Principles for interpretive research

A set of seven principles to be used when conducting and assessing the quality of interpretive field studies in IS, is compiled by Klein and Myers (1999:67). This set of principles are concerned with the elements of *insight* and understanding and is used in support of *critique* and *transformation* – addressed by the set of six principles with regards to critical research in IS. It plays a supporting role in this research. Myers and Klein provide a summary of principles for critical research in table format. It is noted that their set of principles applies to conducting and evaluating interpretive research that has a hermeneutic nature (Klein & Myers, 1999:70). They provide a summary of principles for interpretive field research in table format, which are adapted in Table 2.3 and presented before the discussion of the seven principles.

Table 2.3: Principles for conducting interpreted field research as adopted from Klein and Myers (1999:72)

Group	No.	Principle	Description
Fundamental	1	The fundamental principle of the hermeneutic circle.	All human understanding is achieved by iterating between considering the interdependent meaning of the parts and the whole they form. This principle is **fundamental** to all other principles.

Group	No.	Principle	Description
Critical reflection	2	The principle of contextualization.	Requires **critical reflection** of the social and historical background of the research setting, the intended audience should be able to see how the current situation under investigation emerged.
	3	The principle of interaction between the researcher(s) and the participants.	Requires **critical reflection** on how the data was socially constructed through the interaction between the researcher(s) and the participants.
Philosophical framework	4	The principle of abstraction and generalisation.	Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social interaction.
Sensitivity issues	5	The principle of dialogical reasoning.	Requires **sensitivity** to possible contradictions between the theoretical preconceptions guiding the research design and actual findings (*"the story which the data tell"*) with subsequent cycles of revision.
	6	The principle of multiple interpretations.	Requires **sensitivity** to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study (this is similar to multiple witness accounts even when all tell it as they saw it).
	7	The principle of Suspicion.	Requires **sensitivity** to possible *"biases"* and systematic *"distortions"* in the narratives collected from the participants.

A discussion of the principles follows.

2.5.2.1 Principle 1: the hermeneutic circle

This first principle expects us to oscillate repetitively between the parts and the interdependent whole it forms, until meaning is formed. This principle is fundamental and provides the backbone for the principles to follow. Each of the three cases in this study, is seen as having meaning, but consisting of parts with meaning, with all of them, in combination with the SA&D classes forming a whole. A complex whole may be understood from the meanings attached to its parts, as well as the interrelationships among the parts. In the same way the principle is applicable to each interview as having meaning, in terms of the individual answers and the whole. Each new interview is treated in the same way, but is also seen as forming a whole with regards to the ones already completed. This approach allows shared meanings among participants and the researcher to develop during a number of Hermeneutic Circle iterations, forming a complex whole (Klein & Myers, 1999:71).

2.5.2.2 Principle 2: contextualization

Since a research study has a social and historical background, it is crucial to reflect on this aspect to allow the reader to see how the situation egressed. Reflecting on instructional design of the subject modules, the students doing the modules, the student assistants and the lecturer and how each group perceives the situation, allows the current setting to emerge. The university's unique context, with its own limitations regarding limited means, and different backgrounds in terms of upbringing and schooling may bring a new perspective to the fore. The development of guidelines based on HCI principles are therefore embedded in the context of the study. The disposition in an interpretive study would differ from a positivistic study; relationships between people, content and technology changes constantly and therefore does not allow predictions about the future to be made (Klein & Myers, 1999:73).

2.5.2.3 Principle 3: interaction between the researcher(s) and participants

Principle 3 requires the researcher to reflect on how interaction between the researcher(s) and the participants facilitate the social construction of the data. Therefore both the researcher and participants may be seen as interpreters and analysts of the data (Klein & Myers, 1999:74). Importantly, the researcher influences the research. The lecturer as researcher and the students as participants are interacting through various activities; this allows the development of a system of support and an infrastructure to support meaning. Within this interaction the 15 aspects suggested by Dooyeweerd are used to guide the verbalisation of the HCI experience, culminating in the compilation of the guidelines which are the aim of the study.

2.5.2.4 Principle 4: abstraction and generalisation

Principles one and two, namely the Hermeneutic Circle and placing the study in context, facilitates the discovery of facts and processes particular to the study - through data interpretation – to enable the development of general concepts describing the nature of how people understand and socially interact. The interpretation of data is done through the lenses of the Hermeneutic Circle where meaning is constructed through individual parts and its whole, as well as placing the study in its unique university campus and subject context. With the implementation of three cases, inter-case consolidation becomes viable, which makes abstraction and generalisation possible – to be applicable in other, similar contexts. It is important though, that abstractions and generalisations should be related to the study itself and the reader should see how the researcher arrived at particular insights (Klein & Myers, 1999:75). The use of AR in collaboration with the guiding Dooyeweerd suite of aspects, are in support of extracting abstract and general guidelines routed in the HCI principles.

2.5.2.5 Principle 5: dialogical reasoning

The researcher should be sensitive to the contradictions between what is expected according to literature and what is actually found during the research, especially during later cycles of revision. Hermeneutics presupposes that bias is the starting point of interpretive understanding, but the researcher needs to distinguish between true biases that allows understanding and false biases that brings misunderstanding (Klein & Myers, 1999:76). It is important to be sensitive to the fact that there may be contradictions between the HCI guidelines compiled from literature through the lens of Dooyeweerd's suite of aspects, and the actual modes of analysis – the story told by the data – which may necessitate cycles of revision. Although this is true, it should be noted that the theoretical foundation of the study guides its design. Each participant has a voice and it is possible for these different voices to support, or contradict – one another, and the literature.

2.5.2.6 Principle 6: multiple interpretations

In the same way that multiple witness accounts will differ, even when each individual relates a story as they see it; participants may have different interpretations to the same event. The researcher should be sensitive to the possibility of multiple interpretations and the reasons underlying them. Seeking potential contradictions in viewpoints may enable an improved understanding, allowing scratching beneath the surface to reveal issues with regard to power, economics or values (Klein & Myers, 1999:77). Each participant has their own view and perception of a situation which may result in the supplying of contradicting answers to the same question. This should be seen as multiple viewpoints regarding the same event. This multiplicity of voices should argue with one another in the research findings. This principle may require the researcher to collect data and after analysing it, confront contradictions emerging from the multiple viewpoints, and adjust her or his understanding. The contextual setting may inform this understanding. Combined with suspicion, the principle discussed next may result in deep probing.

2.5.2.7 Principle 7: suspicion

The bias of participants may distort the story told by the data; the researcher should be sensitive to such misrepresentations. Although this principle is included under interpretive research, it is debated whether it is actually a principle to be applied in critical social research only, since it requires the researcher to look beyond the meaning of participants' words to read the social world of actors – with its power structures, limited resources and hidden agendas; this principle is more important in critical than in interpretivist studies and therefore Klein and Myers (1999:77) leave the interpretivist to decide whether this principle should be followed. Since this study is primarily critical in nature, this principle is of value. Therefore in the process of gathering data, the fact that a student's personal context may influence a contribution, is recognised by the researcher. The Hermeneutic Circle principle is used to understand each contribution in the broader context, and taking all contributions into consideration rather than focusing on a particular contribution on its own.

2.5.3 Value position from a critical systems perspective

Two concepts direct this study from a critical systems perspective, namely that of the characteristics of a system, and the boundary judgements of a system. Both are discussed subsequently.

2.5.3.1 System characteristics

A system is an entity which consists of a set of elements that are interrelated and has to accomplish a set of goals (Ackoff, 1971:662; Churchman, 1968:29). Churchman (1968:29) lists five basic considerations that need to be kept in mind when making sense of a system. These considerations are listed and described in Table 2.4.

Table 2.4: Churchman's considerations, as used in this study

Systems characteristic	Diagnosing a system
Purpose	Purpose of the system
Description	The purpose of a system is described as the overall, measurable objective of the system. Churchman (1968:31) argues that the real objective is not always clear, and typically the objective is that which will not be jeopardised by other decisions.
Environment	Environment of the system
Description	Churchman (1968:36) posits that the environment of the system cannot be influenced by the system, but it influences the objectives of the system.
Resources	Resources available to use in the system
Description	Opposed to the environment, resources can be manipulated in the system and utilised to reach the objective of the system (Churchman, 1968:37).
Components	Components of the system
Description	Components are subsystems in support of reaching the overall objective of the system. Each subsystem also has the characteristics of a system as listed in this table (Churchman, 1968:39).

Systems characteristic	Diagnosing a system
Management	Management of the system
Description	Management is the coordination of the resources which are subject to the constraints of the environment – by means of the components – in order to achieve the stated objective (Churchman, 1968:44).

Throughout this study these five characteristics of a system will be used to direct understanding of the underlying systems. In Chapter 3, it facilitates the explanation of the context of the study, while in Chapter 5 and 8 respectively it directs the first step of diagnoses of two AR cycles, one involving repeating students, and the other newcomer students. In the concluding chapter, it is used once more to consolidate the characteristics of the systems that are the subject of this study.

2.5.3.2 Boundary judgements

Regarding the delimitations to a study, Ulrich (1983:247) introduced boundary judgements regarding a social system (S), bounded by its environment – for the purpose of defining a problem as depicted in Figure 2.3. Ulrich (1983) stresses the importance of drawing two boundaries. The first boundary is between S and its environment; what belongs to the problem and what to the problem-environment. The second boundary is set within S; between the involved and the affected.

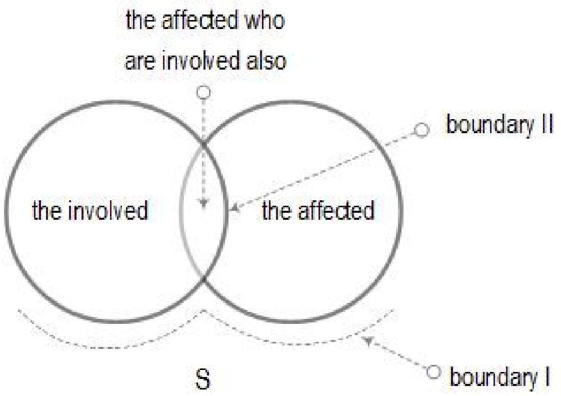


Figure 2.3 Boundary judgements as defined by Ulrich (1983:248)

For the purpose of this study, it is important to identify the social roles with the corresponding concerns of each for the purpose of defining this unique problem. This information is relayed in Table 2.5. The cost imposed on lack of involvement for the affected is the sum total of the contributions made by the involved. In the case of this study, it includes things such as the quality of the IT course, how potential employers perceive the course, which percentage of qualifying students will work in the IS industry

– and specifically in SA&D, how effective learning takes place, and how well future systems will be developed.

Table 2.5: The application of boundary judgements, as defined by Ulrich (1983:247), to this study

Categories of social roles		Social roles from this study	Corresponding concerns
The involved	Client	The North-West University IS employers	Skilled work force in IS
	Decision Maker	University Management	IS curriculum addressing the needs of industry
	Planner	The lecturer responsible for teaching the SA&D subject modules	Maximising learning in SA&D as subject modules
The affected		Students, either repeating, or as newcomers to the subject module(s)	Passing SA&D subject modules
The involved and affected		The lecturer responsible for teaching the SA&D subject modules	Making sense of power structures, beliefs and assumptions in teaching and learning SA&D
The affected that are also involved		The elected SA&D class representative	Supporting the communication between lecturer and students
The involved but not affected		The team of student assistants supporting the students and the lecturer of SA&D.	Supporting the endeavour of supplying prompt and meaningful feedback to students, the guidance regarding the completion of exercises, the communication between lecturer and students

Ulrich (1983:247) refers to groups of people or "*social roles with corresponding concerns*", such as the people involved in the SA&D subject modules. Such a grouping may be categorised according to necessary boundary judgements, namely:

- *The involved*; the people having a kind of resources available to contribute to the effort of planning and implementing an intervention, they have a say in the process at hand – the spectrum of participation includes from one extreme where one only voices concerns to the other end of the spectrum where one has decision competence. Subgroups include:
  - the *client*, in this study, the North-West University (NWU), as well as the IS industry, who provides sources of motivation (purpose) in terms of direction and values,
  - the *decision maker* who provides sources of control (decision) in terms of the means, resources and authority to make decisions, in this study, the NWU management, and

- the *planner* who provides sources of expertise (know-how) in terms of skills and knowledge, in this study, the lecturer.

- *The affected*; a group of people who are actually or potentially affected by the planning and implementation of an intervention. By implication this group is not involved - with a cost imposed on lack of involvement. In this study, the students enrolled for the subject modules, would make up this group. The repeating group of students (Chapter 5, AR Cycle R) is anticipated to be affected more than the newcomer students (Chapter 8, AR Cycle N), and therefore is performed first.
- *The affected who are also involved*; an interrelationship exists between the involved and the affected. Using a loose definition of "*affected*" would make the affected virtually similar to "*involved*", but that takes the focus away from the differences between those affected and involved as opposed to those affected but not involved: to the planner it is important to make this distinction, since the group who is affected and involved can voice concerns in a similar fashion as those who are involved but not affected, which is not the case for those who are affected but not involved. In this study a first *involved and affected* grouping would include the lecturer, while a second *affected who are involved also* grouping would include the elected class representative, lastly the third *involved but not affected* grouping would include the team of student assistants supporting the students and the lecturer. With time, the latter two groupings were developed to support the lecturer.

The union of the involved and the affected belongs to S, the sum total of those living, now or in the future, the social reality in question. They are the social actors defining the content that directs S. In this study S is represented by the SA&D subject modules.

2.6 RESEARCH METHODS

The explanation Midgley (2000:105) used for *method* may help to establish common ground: a method is a technique that is applied in a particular sequence in some cases and cyclic in others, to achieve a specific purpose. Mingers and Brocklesby (1997:491) define a technique as follows:

> "*... a specific activity that has a clear and well-defined purpose within the context of a methodology.*"

As Midgley (2000:105) does for a method, Mingers and Brocklesby (1997:491) do for a technique. They emphasize the fact that a relation exist between a methodology and a technique, where the former focuses on *what* should be done, while the latter on *how* it should be done (Mingers & Brocklesby, 1997:491).

A research method is a *"strategy of inquiry"* (Myers, 1997) that applies the underlying philosophy in a practical setting. A practical setting includes a study's research design, and collection and analysis of data. Before we examine methods and techniques in the latter half of this section, it is necessary to look at the qualitative nature of this research study.

2.6.1 Qualitative traditions of inquiry

Myers (1997) includes four qualitative strategies of inquiry, namely ethnography, GT, case study research, and AR. What Myers calls strategies of inquiry, Creswell (1998:2) epithets *"traditions of inquiry"*. He includes five, namely biographical study, phenomenological study, ethnography, GT, and case study research.

In the discussion that follows, the suggestions of the two authors are combined and six qualitative research settings are discussed; biographical study, phenomenological study, ethnography, GT, case study research, and AR (Creswell, 1998; Myers, 1997):

- *The biographical study* originated in history and sociology (Creswell, 1998:3) with Denzin who first recorded the interpretive biography (Creswell, 1998:5). The focus of a biographic study is on a single individual and it is based on stories or special events, placed in a broader context. Forms include an autobiography, life history, and oral history (Creswell, 1998:49).
- *The phenomenological study* expands on the biographical study; the latter focuses on the life of one individual, while the former focuses on a number of individuals and their lived experiences regarding a phenomenon (Creswell, 1998:51). The focus of phenomenology is to understand a phenomenon (Creswell, 1998:37).
- *A grounded theory study* aims to systematically collect, code, and analyse qualitative data for the purpose of generating a theory (Glaser & Strauss, 1967:18). The developed theory may be presented as a narrative, a visual presentation, or suggestions. Grounded theory differs from other methods because of a continuous interaction among data collected and its analysis (Myers, 1997); the coding of analysed collected data directs future cycles of collection. This method develops theory based on data that are gathered and analysed in a systematic way (Glaser & Strauss, 2017:2).

- *Ethnography* originated in anthropology (Creswell, 1998:3) where a researcher would describe and interpret a cultural system. In an IS context, the researcher would focus on the organisational and social environment in which an Information System is used; interviews and documents are sources of data which is supplemented by data gathered through participant observation (Myers, 1999:4). It allows for an intensive study of a narrow field with the end product being a portrait of a group of people (Creswell, 1998:37).
- *Case study research* closely resembles that of ethnographic research, with the main difference being the emersion of the researcher in the life of the group being studied (Myers, 1999:4). The case study empirically investigates a present-day phenomenon in a real-world context, while the boundaries between context and the case may be overlapping (Yin, 2011:4). It may be done in the paradigms of positivism, interpretivism and CST (Myers, 1997). Data would be sourced through interviews and supplemented by documentary evidence.
- *A study directed through AR* has the dual aim to address "*the practical concerns of people in an immediate problematic situation*" and "*the goals of social science by joint collaboration within a mutually acceptable ethical framework*" (Rapoport, 1970:499). It is clear that AR is a collaborative strategy and that it is concerned with growing knowledge regarding the social science community. Similar to case study research, AR may be done in the paradigms of positivism, interpretivism and CST (Myers, 1997). Its discussion is further pursued in Section 2.6.2 where this method applicable to the study is discussed.

With the traditions of inquiry explained, the focus of the discussion moves to research methods. AR are discussed subsequently.

2.6.2 AR as method for this study

The purpose of this section is to discuss AR, which is the CST research method of choice. The AR understanding is shared regarding the development of AR, the AR process, the refined FMA model, and finally how AR is applied to this study.

2.6.2.1 The development of AR

The development of AR started with research done by Kurt Lewin and the Travistock institute, initially individually, but later on Lewin joined forces with Travistock (Baskerville, 1999:7). Research were war-based, funded by the public sector and relied on quantitative data and computer analyses which fulfilled governments' idea of research (Baskerville, 1999:7). According to Baskerville (1999:8) the positivistic approach to these AR projects corrupted the method and resulted in disconnecting theory from reality, leading to results which are irrelevant. Enid Mumford, who was involved with the Travistock institute, developed a systems development technique she called the ETHICS method, in essence an AR method (Baskerville, 1999:8) focusing on managing change in the critical research in IS (CRIS) paradigm (Stahl, 2007:481). As acronym, ETHICS represents "*effective technical and human implementation of computer-based systems*" with the focus to develop systems in an ethical way (Mumford & Weir, 1979). Checkland also associated AR with systems analysis (Baskerville, 1999:8) when he developed the soft systems method (Checkland & Scholes, 1990). But it was Wood-Harper (1985:169) who introduced AR as a research method when he suggested the multiview approach, also a systems development methodology (Wood-Harper *et al.*, 1985).

2.6.2.2 The AR phases

In essence, AR researches a problem by taking action to improve a study environment; with the action applying criteria to improve the environment (McNiff, 2016:7). Susman and Evered (1978:588) suggest five phases in AR, done in cycles and in a particular context, as represented in Figure 2.4.

The five phases of AR, are described as follows:

1. *Diagnosis*: participants are identified and material gathered regarding the current situation.
2. *Planning for action*: this phase is determined by the outcome of the diagnosing phase, and may include any aspect of the contextual setting. A plan of an intervention is designed to enhance the setting.
3. *Taking action*: similar to phase 2, this phase is also determined by the outcome of the diagnosis phase, and may also include any aspect of the contextual setting. The plan compiled in the previous phase is implemented with the aim to enhance the setting.

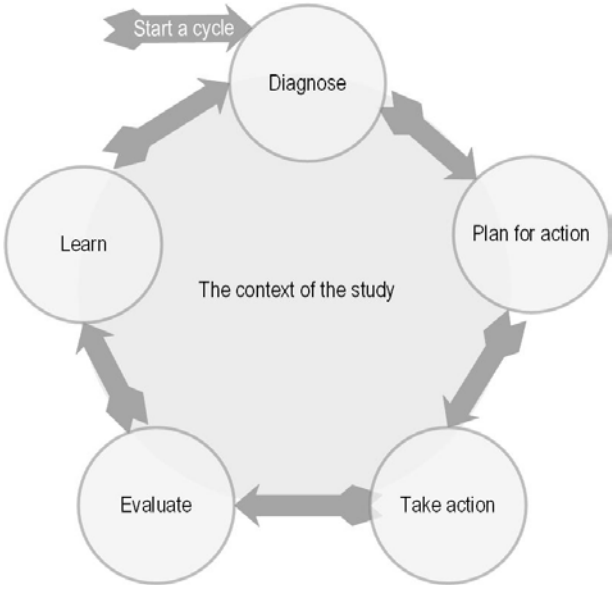


Figure 2.4: AR cycle of five phases as adapted from Susman and Evered (1978:588)

4. *Evaluation*: data gathering such as interviews are utilised to determine the success of the intervention.
5. *Learning specified:* is directed by whether the action is successful or unsuccessful. In the area of application new knowledge is gained through a successful action, while improvements are suggested by an unsuccessful action. Also, on the methodology level a contribution is made and finally a contribution is made on the framework of ideas. This aspect will be clarified in more detail in the subsequent two sections.

Churchman (1968:29), who views the world from critical systems thinking perspective, may be valuable in amending the diagnose phase of the AR cycle suggested above. He defines a system, such as the educational system of SA&D, as a set of inter-related parts to be coordinated in order to accomplish predetermined goals.

He suggests five considerations when meaning is attached to a system as a holistic process of understanding (refer to Table 2.4):

- The *purpose* of the system, which may be related to a number of objectives, allows eventual measurement of performance.
- The application *environment* with the constraints associated, restricting actions.
- The *resources* that are available to be utilised.
- The *components* that makes up a system; these may include activities, goals, as well as performance measures.
- The *management* of the system.

Although Tripp (1990:159) includes four phases in each AR cycle, he suggests an amendment by representing the phases in cycles. He indicates the dual approach of action and research that runs concurrently, which is discussed in the next sub-section (§2.6.2.3) in his cyclic presentation in Figure 2.5.

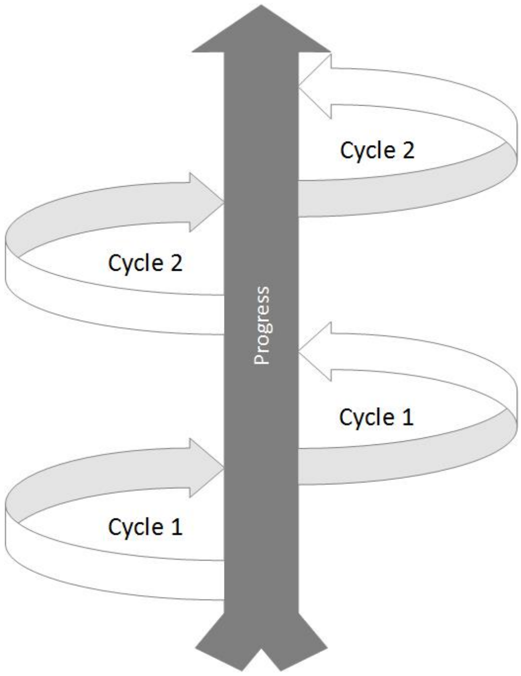


Figure 2.5: The AR spiral as adapted from Tripp (1990:159)

The refinement of the FMA model, which was discussed at the start of this chapter, follows.

2.6.2.3 The refined FMA model - elements relevant to this study

Among the many representations of the AR cycle, is that of Tripp (1990), Checkland (1991) and McKay (2000). In addition to these, the focus of this section moves to the representation of Burns (1994) – in an attempt to amend the AR cycle of Susman and Evered (1978), he uses the shape of the number six (6) to show that AR may be a cyclic process – with the possibility of more than one cycle following one another. McKay and Marshall (2001) build on this shape by creating a three-dimensional six. They argue that AR juxtaposes action and research; or theory and practice, which implies dual aims, creating a need for two AR cycles – the "*one overlaid on the other*", both happening concurrently. The McKay and Marshall (2001:50) representation of the problem solving and research cycles is shown in Figure 2.6. This means that the one cycle will address the problems the researcher encounters during the research and the other will generate new insights on the situation and generate new ideas regarding research. This allows for action researchers to think deeply and act reflectively to ensure deeper understanding and greater clarity on the research and its outputs (McKay & Marshall, 2001:52). The distinction between the problem solving and research cycles is enlightened in the subsequent three paragraphs.

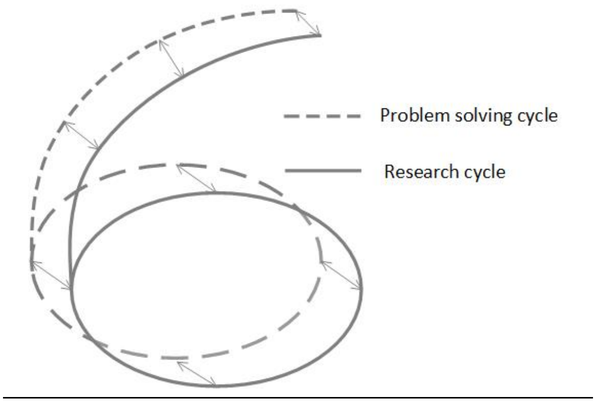


Figure 2.6: AR presented as a dual cycle process (McKay & Marshall, 2001:52)

Building on this insight, and to support the duality approach to AR, McKay and Marshall (2001:53) identified a need to distinguish between two different categories of methods (M) as suggested by Checkland and Holwell (1998b:23), the one M may be called M_R, with R being the research method, namely AR representing the research method and the other M may be referred to as M_{PS}, with PS being the problem solving method. This implies that reflection on learning should occur on M_{PS} and M_R. McKay and Marshall (2001:54) goes one step further by arguing that F, M_R, and A are focused on the design of the research cycle, aiming to answer the study's research questions and generating new knowledge and insights on F, M_R and/or A (F–M_R–A). When applying this line of argument to the problem solving process, we intervene in a problem situation (P), using M_{PS} – which will allow one to learn from doing, McKay and Marshall (2001:55) call this experiential learning. This argument introduces a P in addition to A. There is also a relationship between P and A; it may include the following regarding A which is under investigation:

- P may be a real-world instance of A, or
- aspects of P may overlap with A.

The McKay and Marshall (2001:55) argument is that it is justified to distinguish between P and A, because each have a different ownership – A is owned by the researcher, while P is owned by the participants and/or the stakeholders involved. It is true that the researcher, from an ethical point of view, should take an interest in P with the intention to alleviate the problem, but the participants continue to be the owners of the problem throughout the research. Taking the arguments stated into consideration, the second cycle are focused on solving a problem located in the identified problem situation (F–M_{PS}–P).

Mathiassen *et al.* (2012) build on the work of McKay and Marshall (2001) by analysing a large number of AR journal articles with the focus on how each argument is unfolding. The findings of their research support the claims made by McKay and Marshall; namely that there are dual goals of AR, there is a need to distinguish between research M_R and problem-solving M_{PS}, as well as the need to distinguish between a real-world problem P to amend the area of concern A. In addition, they identified a need to expand the conceptual framing F by distinguishing between two different forms of framing, namely concepts from literature that inform A, which they call F_A, and general concepts from literature that inform the study independent of A, which they call F_I (Mathiassen *et al.*, 2012:350). Here it is important to note that McKay and Marshall (2001) did not make such a distinction of F (F_A and F_I). In this study A is represented by the use of technology to teach technology to students, while I would be represented by the broader philosophical nuances applicable to the study, such as anticipation and retrocipation, as defined by Dooyeweerd – in relation to the suite of modal aspects he defined. In this context, it is anticipated that F_I has little meaning on its own. In the Mathiassen *et al.* (2012) suggestion, F translates to $F_{(A+I)}$, with the emphasis on A, and not so much on I, which leaves us with $F_{(\mathbf{A}+I)}$. Although it is anticipated that the Mathiassen *et al.* (2012) distinction is superficial, the $F_{(\mathbf{A}+I)}$-suggestion is used here to include when communicating contributions from this study.

To highlight the development of the research model, and to link each discussion point with the refined FMA model, Table 2.6 is included.

Table 2.6: A summary: expanding the Checkland and Holwell (1998b:23) model; organised use of rational thought to include the contributions of McKay and Marshall (2001), and Mathiassen et al. (2012)

Elements of research model as suggested by Checkland and Holwell (1998b)	Improvements by McKay and Marshall (2001)	Improvements by Mathiassen *et al.* (2012)
F intellectual framework	- -	F_A framing with regards to A
		F_I theoretical frameworks
M methodology	M_R research	- -
	M_{PS} problem-solving	
A area of concern, methods	A area of concern	- -
	P real-world problem	
L learning or findings on all identified areas	Findings on all identified areas	Contributions to theory and practice (C)

The refined model suggested in this section, is used to guide the communication of the contributions of this study. The depiction of the refinement of the FMA model follows in Figure 2.7.

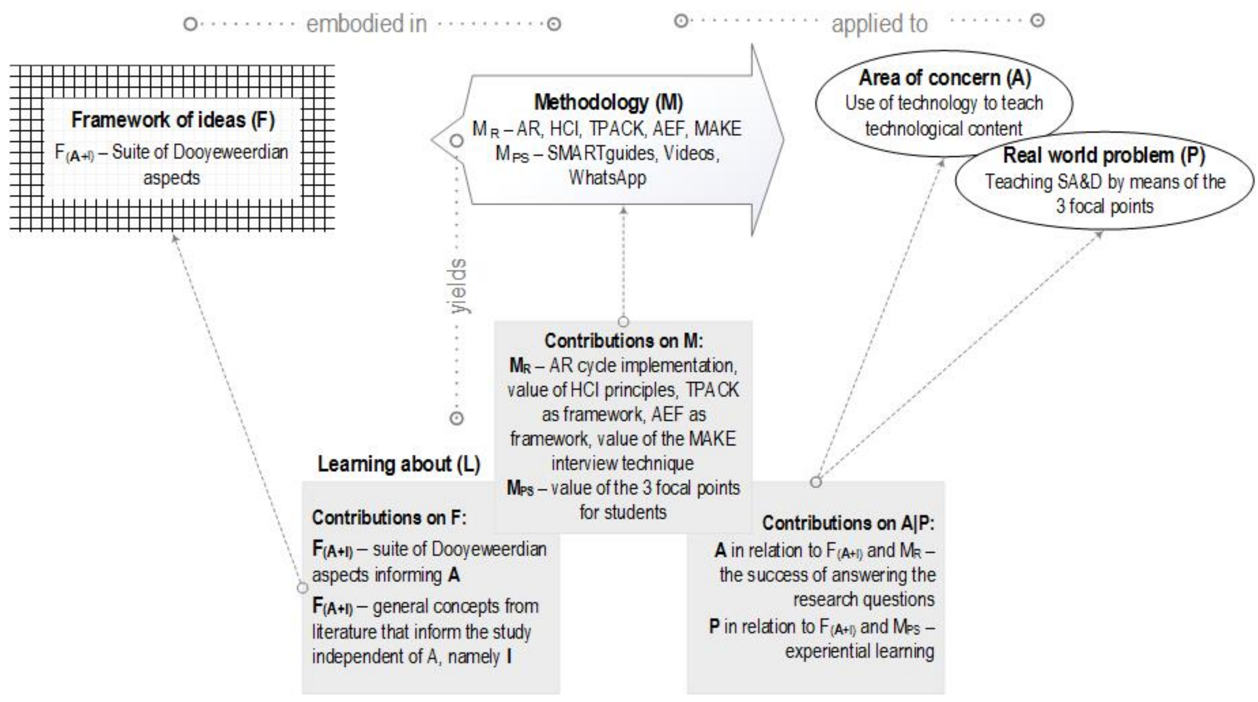


Figure 2.7 The refined FMA model, used for the purpose of communication – applied to this study

The refined FMA model as suggested by McKay and Marshall (2001) and Mathiassen *et al.* (2012), including $F_{(A+I)}$, M_R, M_{PS}, A and P is important to this study, since it outlines the topics for discussion necessary when reporting on an AR project. In Table 2.7, the expanded model is applied to this study, with a mapping between the refined components and the interpretation of each one in the AR context of this research.

Table 2.7: The expanded model of organised use of rational thought applied to this study

Element	Definition (Mathiassen *et al.*, 2012)	The relevance of each element to the study under discussion
F	The intellectual framework of ideas supporting A.	
F_A	The specific concepts from literature supporting A.	Suite of 15 modal aspects of Dooyeweerd.
I	The general concepts independent of A supported by an identified body of knowledge from literature.	
F_I	The general concepts from literature informing the study independent of A.	The philosophy of Dooyeweerd supporting the suite of modal aspects.
M	The methodology identified to be used in the research study.	
R	The research cycle to be utilised in the research study to produce research outcomes.	
M_R	The methods informing the research cycle.	AR cycles applied to the three focal points of SMARTguides, Videos, and WhatsApp groups.
PS	The problem solving cycle which focuses on producing pragmatic outcomes.	
M_{PS}	The methods informing the problem solving cycle.	The AEF and its suggested cycle of aspectual analysis tested by MAKE interviews. HCI, Dooyeweerd's 15 modal aspects. Aspectual analysis, aspectual checklist, and aspectual tree.
A	The area of concern is supported by an identified body of knowledge from literature.	The teaching of technology content, and using technology, guided by the application of HCI principles.
P	The problem situation that is owned by the stakeholders.	Teaching the technology subject of SA&D using technology in the form of the focal points, namely SMARTguides, videos, and WhatsApp groups.
L	The learning that takes place regarding F, M and A.	Learning should take place regarding the guiding framework used, the methodology utilised; and the area of concern in which implementation took place.
C	The contributions to theory and practice with regards to $F_{(A+I)}$, M_R, M_{PS}, A and P	Learning on each element is interpreted, resulting in contributions regarding all the elements identified to form part of the model representing the organised use of rational thought.

2.6.2.4 AR applied to this study

In addition to the guiding lens of the HCI principles, this study is directed by the TPACK framework, as well as the philosophy of Dooyeweerd, with the AEF compiled by Basden, which directs the actions to be performed to ensure that sound research principles are applied to ensure the rigorous investigation using the Dooyeweerdian suite of modalities. The order and breakdown of the chapters, as well as the directive supplied by Basden differs slightly from the general norm. To ensure clarity to the reader, the empirical approach – along with the intertwined literature reviews – are outlined here. The approach is shown in Figure 2.8, in the context of the timeline.

Chapter 3 introduces the three focal points, namely SMARTguides, videos, and WhatsApp, which are forming a golden thread throughout the study. Learning with regards to the refinement of the HCI principles guiding the use of these technological instruments, is anticipated. After realising the similarities between AEF and TPACK, the researcher attempted their integration. This was a complex endeavour which removed the focus from the study, which prompted the individual use of TPACK and AEF to guide two concurrent AR cycles. This approach allows a thorough focus on each of the two frameworks. Chapter 4 investigates HCI principles from literature, as well as the potential TPACK contribution. A list of derived HCI foci is derived from the literature study. TPACK, along the set of HCI foci directs the extraction of a set on *initial guidelines*. In Chapter 5, the AR Cycle R implementation focuses on repeating students who benefited from the splitting of the classes. This cycle utilises the derived HCI foci, as well as TPACK to guide the interviews. The *initial guidelines* are verified and refined by means of the interviews conducted to extract a first set of *updated HCI-TPACK guidelines*.

Chapter 6 investigates the Dooyeweerdian philosophy, with a specific focus on his 15 modal aspects. Chapter 7 focuses on the AEF, which was developed by Basden to facilitate the application of the Dooyeweerdian philosophy in the context of humans using technology. The latter part of this chapter focuses on the aspectual analysis of the three focal points in relation to the derived HCI foci obtained in Chapter 4. The aspectual analysis is prescribed by the AEF. A list of *conceptual guidelines* is obtained at the completion of this chapter. In Chapter 8, the AR Cycle N implementation focuses on the newcomer students who did SA&D for the first and only time. This second cycle utilises the *conceptual guidelines* obtained from aspectually analysing the three focal points, as well as AEF grounded in the Dooyeweerdian philosophy to guide the interviews. The *conceptual guidelines* are verified by means of the MAKE interviews conducted to extract a second set of *enhanced HCI-AEF guidelines*.

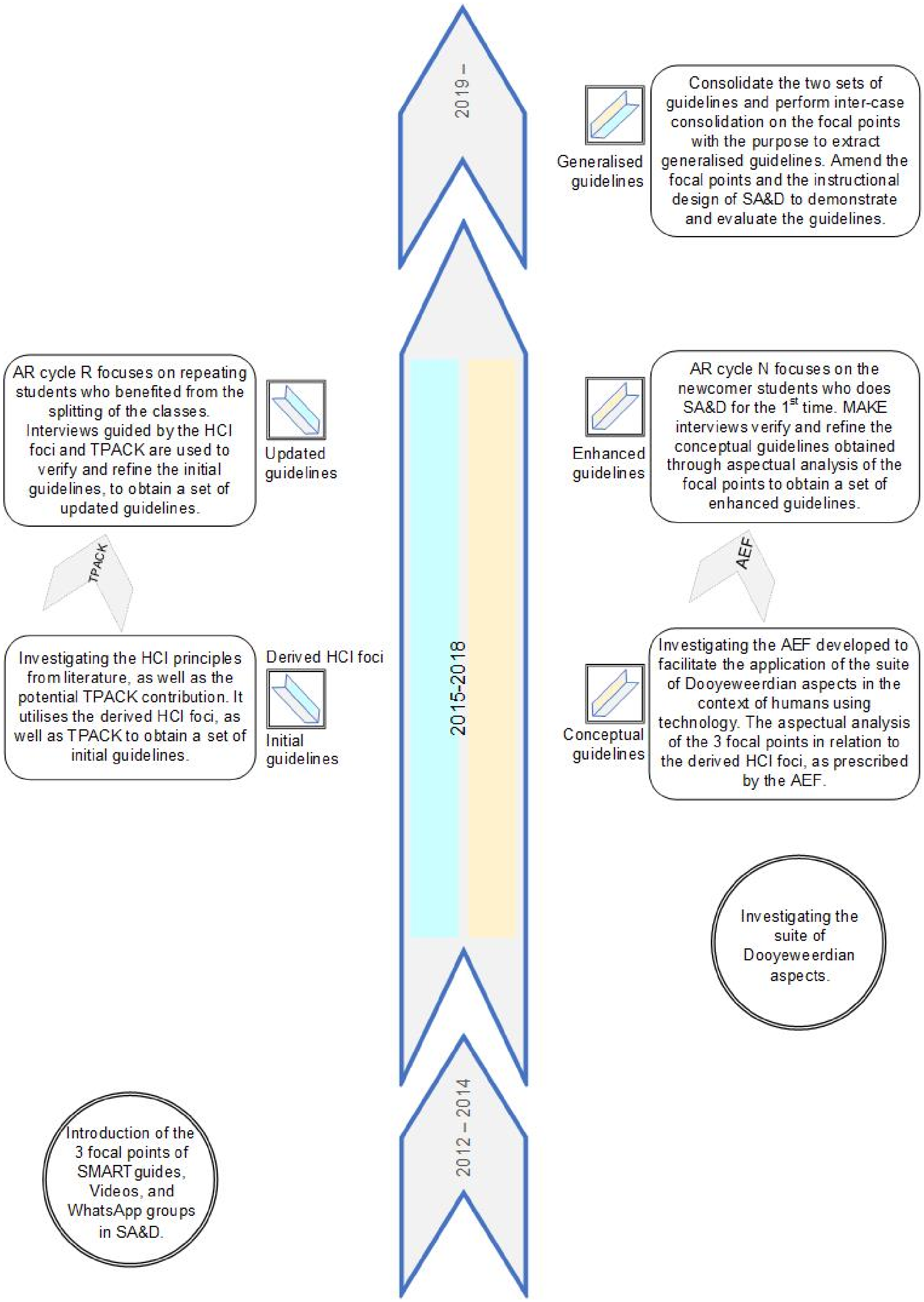


Figure 2.8 The empirical approach – along with the intertwined literature reviews – outlined in the context of the timeline of the study

Chapter 9 uses the two sets of *guidelines* obtained from Chapters 5 and 8 to extract a set of *generalised guidelines*. An emancipatory experience for students is anticipated through the creation and implementation of a set of generalised guidelines that may be applied to the use of technology in an educational setting. A demonstration of such implementations follows, as well as its evaluation in the context of SA&D with the three focal points of this study. Qualitative research techniques

With the overarching epistemology being CST using the notion of interpretivism, qualitative methods are used to conduct this study.

2.6.2.5 Qualitative data collection

Upon the investigation of the six traditions of inquiry discussed in Section 2.6.1, the two data gathering forms, namely interviews and documents are discussed, and its relevance with regard to this study is motivated (Creswell, 1998; Myers, 1997).

Interviews allow the researcher to either collect data to assist in the formulation of research questions, or to collect data that matches the questions associated with the research; in addition it is a purposeful way to collect data that is both valid and reliable (Bell *et al.*, 2018:384; Saunders *et al.*, 2011:318). The type of interview used in a study is determined by research strategy and purpose, which includes the questions to be answered by the study, as well as the objectives of the study (Saunders *et al.*, 2011:320). It varies from very structured with prepared questions for each participant; to unstructured, where the researcher and participants have in-depth conversations (Bell *et al.*, 2018:214; Smith, 2015:30). The focus in this study is on what King (2004:11) labels as in-depth, explorative, "*semi-structured*", or "*un-structured*". Although approaches to interviewing may differ, the goal stays the same; it is to see the research topic through the eyes of the participant and to understand why he or she has a particular point of view; for this reason little structure should be imposed on the researcher, open questions should be posed to the participant, and the focus should be placed on specific events in the life of the participant (King, 2004:11).

The number of interviews to be conducted in a study is a point of contention among researchers, with saturation the aim for some authors (Guest *et al.*, 2006:60), while others argue that research not reaching saturation, does not suggest invalid findings, but rather a phenomenon that has not been fully explored (O'Reilly & Parker, 2013). Saturation originated from GT, as discussed in Section 2.6.1. Guest *et al.* (2006) conducted a study that looked into the number of interviews needed to facilitate a thorough understanding of a phenomenon. They found that between six and 12 interviews are sufficient to reach saturation.

Saunders *et al.* (2011:320) recommend that the interview should be recorded and the recording should be amended with note taking. Interviews may be between the researcher and one participant, or a group of participants where the meeting may be face-to-face, telephonic, or through the Internet (Saunders *et al.*, 2011:321).

Documents provide a valuable source of information and include "*e-mails, blogs, web pages, corporate records, newspapers, and photographs*" referring to what people said or what occurred before (Myers, 2008:153). It may enrich the picture formed by interviews.

To facilitate the practical flow of discussion, data collection is discussed before data analysis is discussed, where in actual fact the process may require that each participant's data is collected, coded and then analysed before the subsequent participant is interviewed – to ensure the grounding of the data for the purpose of theory development (Glaser & Strauss, 1967; Orlikowski, 1993). Therefore, continuous (re)design may be necessary while iterations of data are collected and new notions emerge from its analysis (Glaser & Strauss, 1967:101).

2.6.2.6 Qualitative modes of analysis

In literature a distinction is made between the gathering of data and its analysis in a qualitative study, but doing so may cause challenges for the researcher (Myers, 1997). It is considered that assumptions the researcher would make during data gathering will influence the answers obtained. For this reason, *modes of analysis* may be more descriptive than data analysis. Three data analysis forms, namely hermeneutics, GT, and content analysis, embedded in interpretivism, are discussed (Creswell, 1998; Myers, 1997).

Hermeneutics is the underpinning philosophy of interpretivism, but can also be treated as a mode of analysis – looking at the meaning of text from the point of view that text as a whole has meaning, but its parts can also be interpreted. Creswell (1998) compares three analysis strategies, suggested by three qualitative authors (Bogdan & Biklen, 1992; Huberman & Miles, 1994; Wolcott, 1994): firstly, a general review of all information must be obtained, this can be done by reading through all collected material and making notes (in the margins of text), summaries and reflective notes which can help in the sorting out of information; secondly, feedback can be obtained by taking the information back to the participants as a step to verify data; and thirdly, the process of reducing begins where words used by participants are scrutinised to identify metaphors. Codes and categories are used to sort text and reduce data. Diagrams, tables or graphs can be helpful. A guideline is to use 5 or 6 categories and to develop them to 25-30 in a big database. Finally, categories are related and analytic frameworks developed.

It is clear that there is an affinity between interpretive and critical research that does not exist between either and positivist research (Myers & Klein, 2011:32). Myers and Klein (2011:32) state two reasons for this. First, humans tend to structure their world and experiences in a meaningful way, while natural objects and most animals do not. Interpretive and critical research confirms this fundamental difference, whereas positivist research does not. The second fundamental difference follows from the first, namely the involvement of a double hermeneutic. Giddens (2013:154) refers to "*frames of meaning*" which cannot be mediated through the use of formal logic; in the same way that formal logic does not deal with deliberate contradictions, metaphors, satire and nuances of language to describe practical living.

The Hermeneutic Circle refers to interpreting text as a whole as well as the parts it is made up of; which implies that understanding of the research grows as its interpretation moves from the parts to the whole iteratively (Myers, 2008:185). The double hermeneutic acknowledges that the interpretive or critical researcher does not stand *outside* the research project looking in, but he or she is situated *inside* an environment that has been meaningfully constructed by the group of people in the situation, struggling to grasp it. This does not imply that a researcher should place oneself in the shoes of another person, but rather understand the language and expression of thought of the people being studied (Myers, 2008:190).

Myers (2008:191) posits that in critical hermeneutics the context of the study is seen as part of the text being studied with its corresponding critical analyses. As debated by Klein and Myers (1999:77), critical hermeneutics places more emphasis on the principle of suspicion, which is related to "*depth hermeneutics*" that assumes that text hides meaning which may be unlocked by the researcher's sub-conscious mind (Myers, 2008:191). A consequence of double hermeneutics is that interpretive and critical research involves feedback in two ways: results of the research, and on the research process. This double hermeneutics feedback cycles do not occur in positivistic research.

Grounded theory is an approach developed by Strauss and Corbin (1990). It involves the collection of data, for example using an interview, after which the analysis of that particular interview follows. Interview notes need to be compiled and typed immediately after the interview. Transcription of the recorded interview follows next. ATLAS.ti, a software tool used to aid the coding process, may then be used to apply the coding steps to the documents generated as a result of the interview. Their approach is summarised in Table 2.8.

Table 2.8: Approach for the GT research tradition (adopted from Strauss and Corbin (1990))

<table>
<tr><th></th><th colspan="2">STEP</th><th>Explanation</th></tr>
<tr><td rowspan="10">General STRUCTURE of study</td><td colspan="2">Introduction</td><td>State the problem | Ask questions</td></tr>
<tr><td colspan="2">Research procedures</td><td>Grounded theory</td></tr>
<tr><td rowspan="6">Constant comparing attempting saturation (zigzag between data collection, coding, and analysis)</td><td>Data collection</td><td>Interviews; MIMA communication; General communication & activities, including assignment results, test and examination results, LMS.</td></tr>
<tr><td>Analysis</td><td></td></tr>
<tr><td>Open coding</td><td>Researcher forms initial categories of information; each category is sub-categorised (called properties) to form dimensions.</td></tr>
<tr><td>Axial coding</td><td>Interconnecting categories: a central theme (phenomenon) is identified with possible causal conditions (which influence the central theme), strategies are specified (actions that may result from the central theme), it is placed in context and consequences (outcomes) are outlined.</td></tr>
<tr><td>Selective coding</td><td>Generation of a theory: a story integrating the categories from the axial coding model is written; the researcher may represent it using a diagram; or may use a series of suggestions.</td></tr>
<tr><td>Conditional matrix (not always included)</td><td>Focus on the social, historical and economic conditions influencing the theme researched.</td></tr>
<tr><td colspan="2">Discovered theory</td><td>A theory is generated in relation to a particular situation (in response to a phenomenon).
The theory may be subjected to further empirical testing.</td></tr>
</table>

The steps of open coding, where categories and possible sub-categories of information is developed by identifying outstanding issues emanating from the text; axial coding, where these categories are interconnected because of a coherence or connection between them with the purpose of developing themes; selective coding, where the researcher builds a narrative of the account; and a conditional matrix, a visual representation of the central theme and the related stipulations and effects are not all followed initially. For the first interview it would suffice to apply only open coding with some reflection afterwards, but as new interviews go through the same data collection-analysis cycle, subsequent steps are included since new interviews are perpetually compared to earlier ones. This approach facilitates a state Glaser and Strauss (1967:61) refers to as "*saturation*", a point where no new insight into a category is gained when new interviews are done.

The GT approach is methodical and mechanistic to an extent. With time the ideas of the originators were simplified. Since qualitative researchers "*learn by doing*" (Dey, 1995:6), the data analysis needs to be revised and custom-built. According to Creswell (1998:142-146) this does not imply intuitive, soft and relativistic research, he posits that although authors write each study up uniquely, the analysis process conforms to a "*general contour*" best presented by a spiral. This implies that when a researcher analyses qualitative data, a linear approach is not followed, but rather a spiral one where data management – where files and directories are used to organise data – starts the process, it evolves to reading the collected material to get a sense of the database and then writing notes and reflecting on it; describing, classifying and interpreting followed by coding and categorising which forms the next cycle in the spiral. The final phase of the spiral, namely the data, are presented through pictures, tables, graphs, matrixes and trees. Eventually content analysis developed from GT.

Content analysis is a research method which allows the researcher to systematically qualify (and/or quantify) phenomena, and its purpose is to facilitate understanding of the data while being objective (Elo & Kyngäs, 2008:108). Although both qualitative and quantitative data may be the subject of content analysis, the focus of this study is on qualitative data. Two approaches are suggested by Elo and Kyngäs (2008:109), namely undirected and directed, each determined by the purpose of the study. Without sufficient former knowledge on a phenomenon, the approach of undirected content analysis extracts categories from the data. This approach includes the observance of specific occurrences that are grouped into more general categories, therefore moving from the specific to the general. When sufficient knowledge exists about a phenomenon, and testing a theory may be the purpose of the study, the approach of directed content analysis is based on the earlier theory and therefore moves from the general to the specific.

Elo and Kyngäs (2008:109) suggest three phases of content analysis, namely preparation, organising, and reporting as depicted in Figure 2.9:

1. Preparation phase: unfortunately no rules exist for the analysis of data, except that it should be classed into smaller content categories – a unit of analysis – such as a theme. It is possible that a unit of analysis may carry multiple meanings, or include more than one sentence. In addition, the researcher needs to decide on whether only the transcribed text will be analysed or the latent content, including silence, sighs, laughter, posture, etc., as well. For this reason it is important for the researcher to make sense of the data by becoming immersed in it, reading it more than once until insights become apparent.
2. Organising phase: the organising phase regarding the undirected process are similar to the approach followed in GT, open coding is done when headings are generated to cover all the material, then headings are grouped into categories – to reduce the groupings. The purpose is to describe the phenomenon, which is done in general terms during abstraction. Directed content analysis involves testing categories, concepts or models. To accommodate this, a matrix of analysis, based on extant work, including theories, models, and literature, should be developed. This matrix may be structured or unconstrained, and is intended to guide all data to be reviewed for content to be coded in correspondence to the categories included in a structured matrix, and within the bounds set – following the principles of undirected content analysis – in an unconstrained matrix. Trustworthiness should be ensured by including sufficient detail to allow the reader to relate to what the analysis process entails and how the analysis was carried out, as well as transparently showing the link between data and results through the use of illustrative tables. Reliability of interpretations and eventual findings may be demonstrated by either enabling another researcher to do the analysis or redoing the analysis by the researcher, after a time interval. The use of agreement coefficients may support this aspect. In addition, the literature review will allow readers to understand the formulation of original data categories. Qualitative data analysis software programs, such as ATLAS.ti, can assist with content analysis.
3. Reporting on the process and results: with results being formed through a process consisting of a number of phases, reporting on a study and presenting the corresponding results may be a daunting process. Challenges may include: describing parts of the process in much detail, and other parts in a compressed way – result in

unbalanced reporting; compressing data too much – the point if protecting the integrity data during analysis is lost, and summarising conclusions without the inclusion of supporting excerpts – the richness of the original data is ignored. An incomplete analysis process should also be avoided when reporting: the inclusion of too many headings in a category, not abstracting the data, and having too many categories may lead to ostensibly simple results.

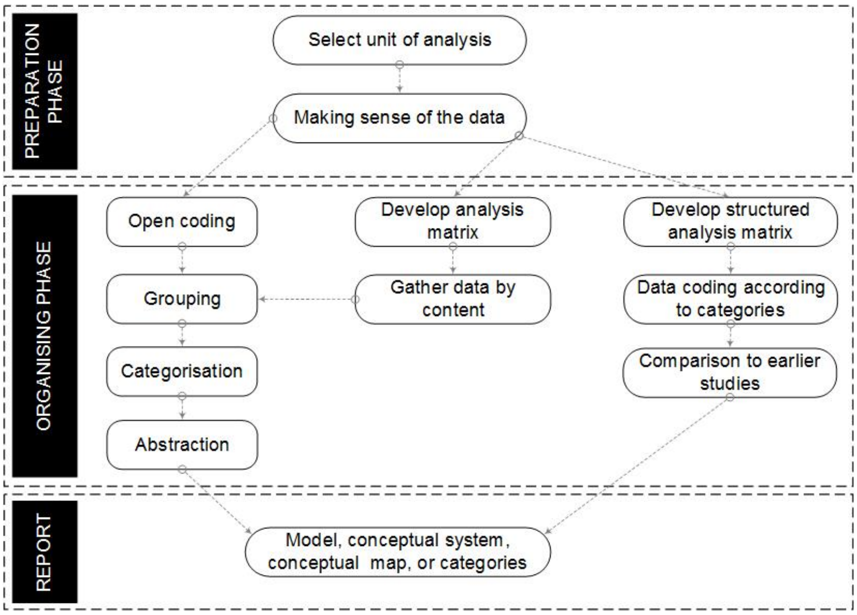


Figure 2.9: The content analysis process as adapted from Elo and Kyngäs (2008:110)

The application of the content analysis process is explained next.

2.6.2.7 Data collection and analysis applied to this study

All AR cycles mainly utilise unstructured interviews on the overarching implementation and, as well as the focal point implementations. In AR Cycle N, derived HCI foci and the framework for TPACK interaction guide unstructured interviews – in Chapter 5. An interview technique, based on the Dooyeweerdian perspective, namely MAKE is discussed in depth in Chapter 7. In short, MAKE is an unstructured interview technique where 10 of the 15 modal aspects developed by Dooyeweerd are used to support participants' reflection on their experiences in a particular environment to determine whether the environment addresses the whole person.

In one of the focal points, namely summative assessment, a MIMA called WhatsApp, is used to create a platform for students to communicate with their peers when preparing for assessments. The WhatsApp group generates data being categorised as a document.

These WhatsApp conversations among students and the lecturer will be used to inform the study.

The Hermeneutic Circle with its double hermeneutic reporting is important as mode of analysis of this study. The effect is threefold: firstly, the presuppositions of the researcher is assumed to affect the gathering of the data, and the questions posed to participants will determine their answers; secondly, analysing data affects the data, and the data affect its analysis; and thirdly, the meaning of words used in the data need to be understood in the context of a particular interview.

2.7 RESEARCH DESIGN

Although subsequent chapters will inform the research design of this study in more detail, the information related up to this point, is sufficient to allow the compilation of a visual research design. The research design for this study was depicted in Figure 2.10.

The first chapter orientates the study, while Chapter 2 reflects on the literature with regard to the research philosophy applicable to this study, and Chapter 3 supplies the context of the study which includes education in South Africa, higher education in South Africa, and teaching and learning of IS, with a special focus on SA&D. Along with SA&D, attention is given to the three technology instruments of instructional design, formative guidance, and summative assessment which are introduced as the three focal points of this study.

Chapter 4 studies the extant research on HCI principles, along with the TPACK framework regarding the value it may provide this study. A list of derived HCI foci, as well as initial guidelines are deliverables of this chapter. In Chapter 5, the application of an AR cycle, facilitates the verification and refinement of the initial guidelines in the context of recording progress with regard to the teaching of the two subject modules of SA&D. Interviews, based on the derived HCI foci and the TPACK framework, with alumni from the repeating groups of students (R) attending the systems analysis and design (SA&D) subject modules are conducted and analysed. Updated guidelines are obtained.

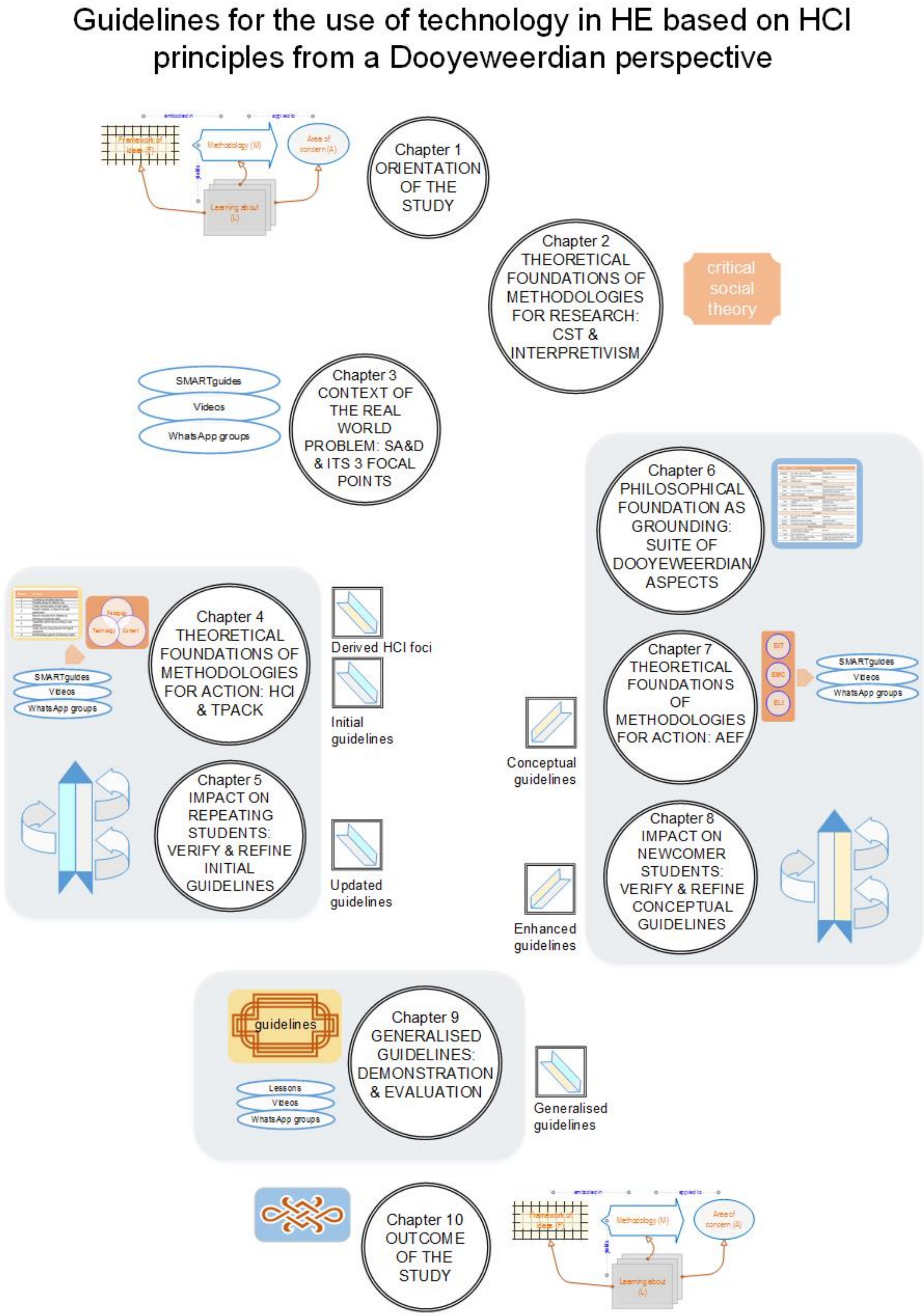


Figure 2.10 The research design for this study

Chapter 6 investigates the philosophy of Dooyeweerd, a known philosopher. Chapter 7 explains the AEF that is based on the Dooyeweerdian philosophy. The AEF directs aspectual reflection of the three focal points of this study in the form of aspectual analyses, aspectual checklists and aspectual trees. A list of conceptual guidelines is the deliverable of this chapter. Chapter 8 focuses on an AR cycle which facilitates the verification of the conceptual guidelines in the context of recording progress with regard to the teaching of the two subject modules of SA&D. MAKE interviews, based on the derived HCI foci and the AEF, with alumni from the newcomer groups of students (N) attending the SA&D subject modules, are conducted and analysed. Enhanced guidelines are obtained.

In Chapter 9, generalised guidelines are extracted from the two sets of guidelines obtained from Chapters 5 and 8 respectively. A demonstration of the improvement of the three focal points of SA&D is included and evaluated. The purpose is to apply the generalised guidelines obtained from this study to the systems analysis and design subject modules.

All the AR cycles incorporates HCI principles identified from literature and applicable to this context, and has the aim to refine the technology guidelines that is the focus by this study. In addition each cycle aims to improve the learning experience of the students.

Chapter 10 summarises the study, and concludes it.

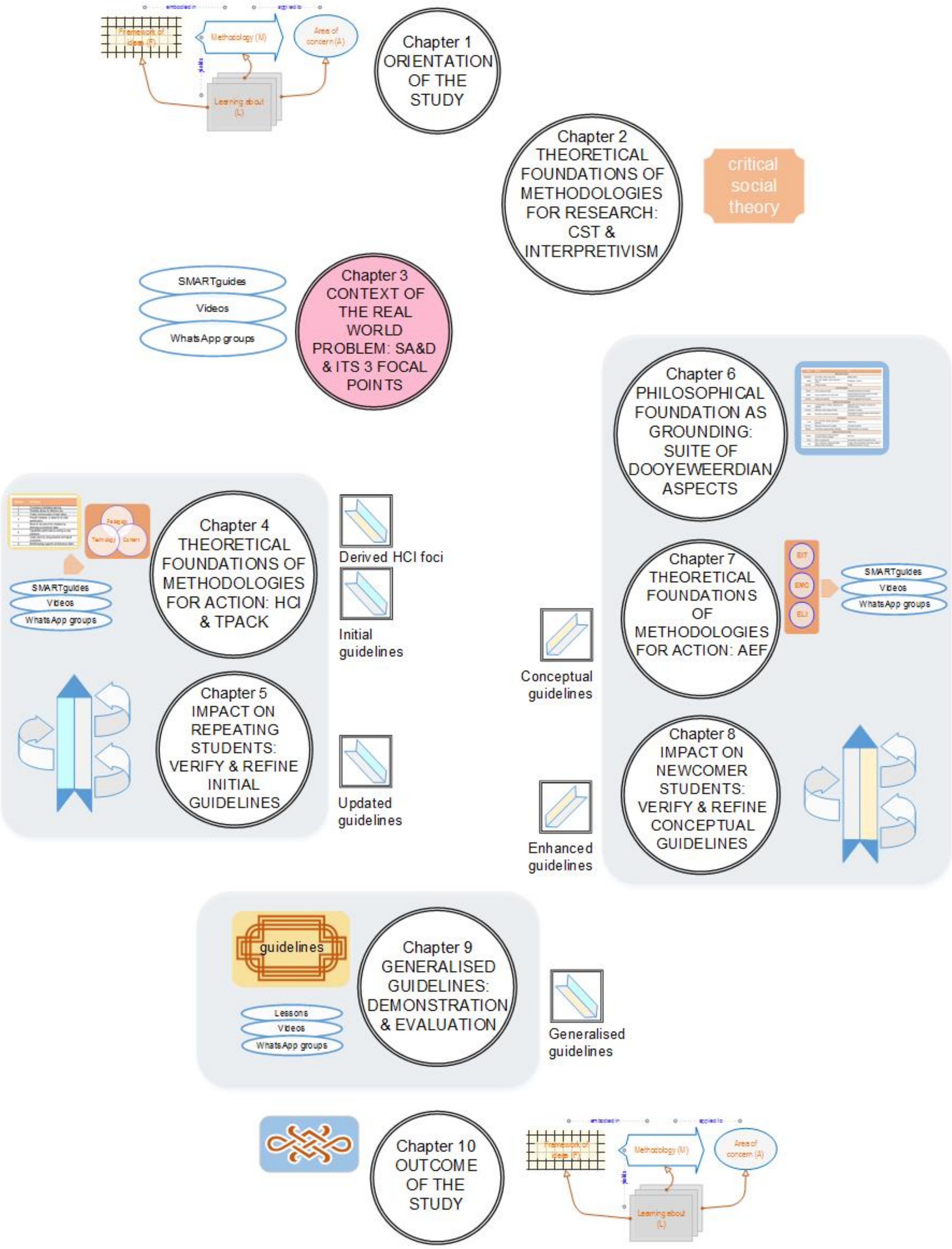
2.8 SUMMARY

Fulfilling the purpose of this study, which is to gain an understanding of the use of technology in higher education and to develop guidelines for the use of technology, based on an understanding of HCI principles – from a Dooyeweerdian perspective, this chapter addresses the first theoretical objective, namely to clarify CST applied in a case environment, using AR cycles.

The model by Checkland and Holwell (1998b:23), used to draw a research plan for this study aided in understanding the research. This chapter focused on the intellectual framework (F) and specifically addressed the role that CST plays, as well as the supporting role of interpretivism. Two sets of validation principles; that of Myers and Klein (2011) for CST, as well as the set for conducting interpretive field research (Klein & Myers, 1999) are explained and placed in the context of this study. Attention is given to the scope of the study, ensuring a well-bounded and well-defined study. The research setting suitable for critical and interpretive research are selected for this study, namely AR are described and linked to its associated data collection and analysis strategy. The refinement of the Checkland and Holwell FMA model is debated to highlight the categories of communication in an AR project.

The next chapter introduces the use of technology in the educational setting of teaching and learning SA&D. The implementation of three technological instruments in the subject modules of systems analysis and design is introduced as well.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



3 CONTEXT OF THE REAL-WORLD PROBLEM: SA&D & ITS THREE FOCAL POINTS

3.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education based on human computer interaction principles from a Dooyeweerdian perspective.

In order to achieve this primary objective, this chapter places the study in the context of systems analysis and design, and introduces the three focal points of this study, namely; instructional design (SMARTguides), formative guidance (videos) and summative assessment (WhatsApp), which form a golden thread throughout the study. It addresses the first reflective objective (R01). In essence none of the study objectives are addressed by this chapter.

This chapter supplies the context for the study and focuses firstly on the elements that are relevant to this study (§3.2). It also covers the South African context (§3.3), along with the topics of the subject modules of systems analysis and design (§3.4), the incorporation of technological instruments into the subject modules (§3.5) and a section concluding this chapter with a summary (§3.6).

3.2 ELEMENTS RELEVANT TO THIS STUDY

As explained in the preceding chapters, the refined Checkland and Holwell (1998b:23) model, are directing the research plan for this study, as shown in Figure 3.1. The focus of this chapter is on a real-world problem (P), namely the subject modules of systems analysis and design (SA&D) and how it is taught to information technology (IT) students, with a specific focus on the three cases of technological instruments of instructional design, formative guidance, and summative assessment.

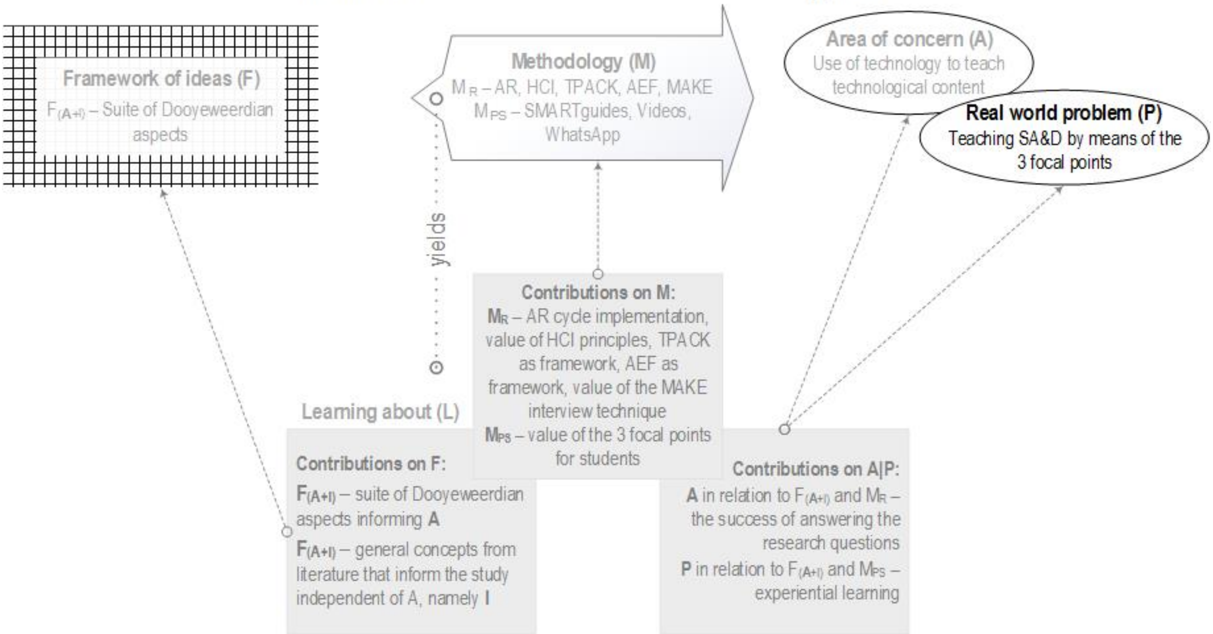


Figure 3.1: The elements relevant to this chapter[3]

3.3 THE SOUTH AFRICAN CONTEXT

Coming from a background of Apartheid, education in South Africa faces a variety of challenges: the dropout rate between grade 1 and 12 is more than 50%; inequalities exist between language groupings and across geographical areas – with reading skills a major concern since many pupils do not progress from *learning to read* to *reading to learn*, a requirement in grade 4, and therefore fall behind more and more as time passes; and South African pupils perform the weakest among all participating countries in international tests where mathematics and science are the focus (Spaull, 2015:34).

In addition to the challenged school system, the unemployment rate in South Africa is at a high 35%, with the majority of unemployed people among the unskilled and semi-skilled workforce. This places much emphasis on higher education in South Africa, with the perception being that a qualification guarantees a job. In the field of Information and Communication Technology, where the needs are not fulfilled by the higher education system, this is especially true (Jacobs & Sewry, 2010; Seymour *et al.*, 2004).

[3] The elements concerned in the current chapter are printed in black, with other elements in grey.

The North-West University, with close to 70 000 students, is the third largest among the 26 public universities of South Africa, and plays a large role in the education of the masses (North-West University, 2020; Universities South Africa, 2017).

Studies with SA&D education as focus in the South African context, include only one, that of Tanner and Scott (2015), "*A flipped classroom approach to teaching systems analysis, design and implementation*" – a positivistic study to gauge the success of a reverse classroom. In SA&D and Software Engineering, a closely related subject field, studies across the globe also focus on the improvement of teaching and learning of the subject matter. Some of these include using a card game (Baker *et al.*, 2005), game design (Cagiltay, 2007; Claypool & Claypool, 2005), and a real project (Gnatz *et al.*, 2003). With all the studies looked into, focusing on the investigation of techniques to improve the involvement and therefore the successful learning of the knowledge, skills, and attitudes of students, a gap was identified. A gap exists in the literature regarding the compilation of a set of guidelines compiled from the perspective of a theoretical framework and embedded in human computer interaction principles, to guide the use of technology in the teaching and learning of systems analysis and design.

3.4 SA&D INSTRUCTIONAL DESIGN

The SA&D context described in this section, reflects the situation that was implemented when the researcher started teaching the subject modules under discussion during 2011. The introduction of three technological instruments since 2012 are also discussed. The two action research (AR) cycles that follow in Chapters 5 and 8 respectively, describe how the situation evolved over the implementation period. The experience of how two groups of students, those repeating the first module, and the ones new to the subject modules, differed with regard to teaching and learning. With the inclusion of a demonstration of improvement of the three focal points in Chapter 9, the possibilities in terms of a new dispensation at the North-West University (NWU), situated in South-Africa, where a variety of courses are offered at three campuses, namely, the Potchefstroom Campus (PC), the Mafikeng Campus (MC) and the Vaal Campus (VC), is discussed. This situation, along with the evaluation of the demonstration of the three focal points, opens the opportunity for the implementation of a future AR cycle.

When the researcher started teaching the subject modules under discussion, each campus functioned independently from the others, although some courses were aligned.

The VC is the smallest campus with less than 10,000 students which mirrors the South African population. The Baccalaureus Scientiae in IT course was partially aligned with the same course offered on the PC. Systems analysis and design is a subject offered as two consecutive 16 credit modules – over a year – in the second year of the course. One or both modules are also offered as part of a number of other Baccalaureus Scientiae courses.

Yearly, the largest component of the students in the class offered on the VC is made up of black South Africans (more than 85%), then white South Africans (less than 10%), the rest is made up of members of the South African Indian community (roughly 2%), coloured South Africans (roughly 2%) and lastly, black international students (roughly 1%). A high percentage of students come from disadvantaged communities, therefore some students struggle with limited funds to pay fees, many students have their own children, some travel far to and from classes and others have insufficient housing, while mal-nutrition is a reality for some students.

3.4.1 Outcomes

The subject SA&D is offered as two modules, SA&D I that focuses on systems analysis and SA&D II that focuses on systems design, and – to a lesser extent – on systems implementation and support. As subject SA&D teaches the information systems (IS) development life cycle, using a hypothetical methodology. The outcomes of the course modules are listed in terms of knowledge, skills and attitude; capabilities reflected as student expertise, experiences related to course work, and also the talent of an individual in Table 3.1.

Table 3.1: Outcomes of SA&D

Capability	Systems analysis and design I	Systems analysis and design II
Knowledge	After having completed the course learners will be able to demonstrate that they accumulated sufficient knowledge of, and insight into the phases and techniques of the systems development life cycle in order to be able to apply this knowledge to the planning and analysis.	After having completed the course learners will be able to demonstrate that they accumulated sufficient knowledge of, and insight into the phases and techniques of the systems development life cycle in order to be able to apply this knowledge to the planning and design of a system. Although the implementation of a system is not the primary focus of this module, implementation is important to determine the value and success of the analysis and design.

Capability	Systems analysis and design I	Systems analysis and design II
Skills	After having completed the course the learner will be able to prove that he/she can apply the phases and techniques of systems development in the context of a project. Learners must be able to manage a practical project by using project management techniques. The learner will be able to think and act creatively and with a view to solving the problem at hand when a computerised system is analysed. Group work must be completed successfully.	After having completed the course the learner will be able to prove that (s)he can apply the phases and techniques of systems development in the context of a project. Learners must be able to manage a practical project by using project management techniques. The learner will be able to think and act creatively and with a view to solving the problem at hand when a computerised system is designed and developed. Group work must be completed successfully.
Attitude	Systems are developed for users, and their preferences and working methods must be taken into account during systems analysis.	Systems are developed for users, and their preferences and working methods must be taken into account during systems design, therefore the analysis completed in SA&D I should be according to the needs of users.
	Systems analysis must be completed accurately and according to the agreed upon manner.	Systems design must be completed accurately and according to the agreed upon manner. System implementation is also undertaken to test the success of both the systems analysis and its design.
	Information about the client should be treated with the necessary confidentiality.	Information about the system should be treated with the necessary confidentiality.
	Computer resources should be used ethically and responsibly.	Computer resources should be used ethically and responsibly.

3.4.2 Reflective learning

Reflective practice plays an important role in the facilitation of the lecturer's understanding of how students learn and obtain a solid understanding of a subject such as SA&D. It also supports the descriptive-prescriptive debate. It allows the lecturer to make changes regarding how material is offered in guiding students to engage with material; to enable more effective learning. Also, when students apply study material, reflection of the material is an important notion. Mathiassen (1998:68) coined systems development[4] as "*reflective systems development*" to give recognition to the ideas of Schön (1983) on how professional people know-and-reflect in action.

In an educational setting, and specifically when teaching SA&D, these phases imply that students need to practically apply the theoretical concepts studied, that they are allowed to make mistakes, realise their mistake(s) with the help of the lecturer, upon which they

[4] Sommerville (2011:273) includes three overlapping stages in systems engineering, namely procurement – which ensures that the new system can be developed; development – which includes the analysis and design of the system, as well as its development and implementation; and operation – which supports the system in operation.

revert back to the underlying theoretical concepts which is directing corrective action (Osterman, 1990:134). Therefore, reflective practice has some implications in an educational setting such as SA&D. Firstly, the instructional designer needs to take the essence of the subject matter and how it is implemented in the work environment into consideration to enable the *simulation* of the real world. Mathiassen (1998:68) describes it well when stating that, although methods and tools are important when shaping and improving practices in systems development, they have a limited impact. It is therefore more important to cope with a specific anticipated work environment; it may be unstructured, which might cause uncertainty and instability, and value-conflict may be experienced. System developers also need to engage in dialogue, they need to reflect and open their minds to move beyond general professional knowledge and obtain new insights into their situation. Secondly, the essence of how to teach SA&D needs to be taken into consideration by the lecturer. To make this possible, *assumptions on learning* need to be matched to potential pedagogical strategies. Osterman (1998:8) lists four assumptions about learning, each matched with a pedagogical strategy, namely:

- learning is seen as an active process that needs to be controlled by the student and therefore learning should *engage* the student,
- learning should build on prior knowledge, therefore opportunities should be created to *explore, articulate and state knowledge*,
- learning takes place when students are confronted with problematic experiences, therefore they need to be challenged to be aware of *problems* and re-examine their views by means of reflection,
- students find it easier to integrate new knowledge when they perceive it as effective; therefore opportunities should be created for students to test how well new ideas work.

Thirdly, the lecturer needs to *reflect* on her or his own teaching and learning. It entails having empathy with the students and walking in their shoes. In some cases this may be difficult to do, since knowledge on the subject matter is not as new for the lecturer as it is for the student. It helps to have a particular attitude towards the subject matter; in this regard Schön (1983:156) distinguishes between an expert and a reflective practitioner. An expert is presumed to know and needs to maintain that stance independent of uncertainty; the expert role is sustained by keeping a distance from the student and much effort is put into claiming some status as expert. On the other hand, a reflective practitioner presumes to know, but accepts that the students may also bring relevant knowledge to the topic which may allow learning to take place for both parties; the reflective lecturer seeks connections with the students' thoughts and feelings to facilitate the discovery of knowledge; this allows a connection between the lecturer and the students and there is no need to maintain a professional facade.

This to-and-fro discussion between prescribing what should happen and describing what has happened in the mind of the researcher and the enabled progress in the redesign of every aspect of the cases throughout implementation phases, in some cases result in only small adjustments, but in all cases endeavouring towards an improved learning experience for the student.

3.4.3 A systems perspective on SA&D

A system includes a set of parts connected to fulfil a set of objectives (Churchman, 1968:29). He directs the diagnosis of a system, such as the educational system of SA&D with his suggestion of five considerations: purpose, environment, resources, components, and the management. The description of each consideration was listed in Chapter 2 (Table 2.4).

In this section, the instructional design as it was implemented before the three focal points were fully introduced, is presented as a "*system*" in the systems approach. In this section the instructional design of the SA&D module for repeaters is viewed as a "*system*" in the context of the systems approach, as shown in Table 3.2. In the table each characteristic is described, which is followed by a contextual reference. The information regarding the two iterations will be stated in subsequent chapters (Chapter 5 & 8).

Table 3.2: Using Churchman's considerations to place the study in context

Systems characteristic	Diagnosing the instructional design of SA&D
Purpose	Purpose of the instructional design
Description	The purpose of a system is described as the overall, measurable objective of the system. Churchman (1968:31) argues that the real objective is not always clear, and typically the objective is that which will not be jeopardised by other decisions.

Systems characteristic	Diagnosing the instructional design of SA&D
Context	The objective of the instructional design as a system, is to guide each student to develop in terms of their SA&D skills, and as life-long learner. Therefore, the lecturer envisages supporting all students to participate to their full capacity by making focused resources available to them, and to support them to utilise resources according to their individual needs. The fact that IT students are the subject of the teaching of SA&D, makes the development of technological instruments tempting. Importantly, the point of departure is that each instrument elected, has to have an underlying educational purpose. Although continuous learning is important in the workplace for all employees, even more so in an IT career, with the constant development of technology and its supporting applications. Although much emphasis is placed on pass rate in the university context, the overall purpose of the instructional design was rather on enriching the learning environment to ground future learning. In support of the educational purposes, the classes are developed to stimulate students to direct their own learning through the use of videos and other instruments. Seeing students struggle to prepare for assessments, especially while off-campus, motivated the use of their already existent mobile devices to support their learning. An opportunity to form part of a group of academics to pilot the implementation of interactive electronic study guides, opened the way for the inclusion of a technology instrument in the form of an interactive electronic guide.
Environment	Environment of the instructional design
Description	Churchman (1968:36) posits that the environment of a system cannot be influenced by the system, but it influences the objectives of the system.
Context	The environmental aspects of this study are: • Poor socio-economic background of students. • Limitations in practical laboratories on campus due to sharing of computer laboratories among disciplines. • Specific functionality of the LMS outside campus boundaries. • Limited contact time: at the VC limited time were allocated to SA&D, initially with two double contact sessions, each lasting 80 minutes, and (during the last classes related to this research), a short double contact session of 75 minutes and a long double contact session of 90 minutes were allocated, one allocation for a theory class and the other allowing practical work. • Limited study hours per module in the programme, 160 study hours of which the majority is outside formal contact hours, of which most is reliant on computer laboratories.
Resources	Resources available for use in the instructional design
Description	Opposed to the environment, resources can be manipulated in the system and utilised to reach the objective of the system (Churchman, 1968:37).
Context	In support of the subject plan (Chapter 3, Figure 3.2) preceding the AR cycles, the learning resources which were relied upon to support students in their endeavour to internalise concepts, with the motivation for the inclusion of each, are listed in Table 3.3. The instruments which are contributing to the participation mark of the students, are shown in Table 3.4.
Components	Components of the instructional design
Description	Components are subsystems in support of reaching the overall objective of the system. Each subsystem also has the characteristics of a system as listed in this table (Churchman, 1968:39).

Systems characteristic	Diagnosing the instructional design of SA&D
Context	Different strategies for dividing the systems into components are possible. These include (1) focussing on teaching as one component and learning as another, or (2) focusing on different study units as components. However, from historical results, it was decided to focus on the students themselves when identifying the different components of the system. By splitting the original class to accommodate the different needs of repeating students, the objective of the system may be achieved more effectively. Therefore, the overall system is managed in terms of two components, namely a class group of repeaters and a class group of newcomers. However, these class groups are in turn subsystems of SA&D, each with their own components. Their components are identified in terms of teaching and learning, as well as a further division in terms of study units. Teaching is the driving force in that it kick-starts the learning component. In the traditional sense, teaching is seen as a lecturer explaining concepts pertaining to the subject matter to students, but being a lecturer includes more than just teaching, which refers to the next consideration, that of managing the class. In addition, the discipline, in this case IT, is important, where teaching and learning should take place in such a way that promotes the "way things are done" in IT. In the case of SA&D – in each of the two components – teaching and learning are broken down into 10 study units completed over 10 weeks in each of the two semesters. The act of teaching is juxtaposed with that of learning, which is both the responsibility of the students as learners, and lecturers as learners. Students are learners of the subject matter offered, skills required in the application of the material, and the attitudes supposed by the students in applying the material. Lecturers are expected to gain knowledge, skills and attitudes in teaching the subject module material. While learning, students need to be guided in terms of how close their knowledge, skills and attitudes are with regard to what is expected. Informal learning opportunities includes; class work and supplemental instruction, as well as formative assessments such as tests which both afford feedback opportunities to guide students. The employment of senior students who may act as student assistants and supplemental instructors allows the luxury of being able to supply feedback in a short space of time – in some cases immediately – by students who understand the learning which needs to occur to enable optimal understanding.
Management	Management of the instructional design
Description	Management is the coordination of the resources which are subject to the constraints of the environment – by means of the components – in order to achieve the stated objective (Churchman, 1968:44).

Systems characteristic	Diagnosing the instructional design of SA&D
Context	In order to understand the coordination of the resources and the environment of the SA&D module, information is presented on the individual semester modules. The focus of the first semester subject module being systems analysis, includes background information, project management, and the activities encompassed by the phases of systems analysis (requirements gathering, use-case modelling, data modelling and the analysis of the data, process modelling, and feasibility analysis). The focus of the second semester subject module is systems design, which include the activities encompassed by the phases of systems design (application modelling, database design, output design, input design, and user interface design). Although system construction and implementation, along with systems operations and support, are strictly not part of SA&D, these two phases are also addressed to allow students to experience the effects of the analysis and design they have done for their system. Lastly, object-oriented analysis and design are included in the syllabus. A textbook, compiled by Bentley and Whitten (2007) is prescribed as text book. The initial intention regarding the subject modules, were to offer the modules in a structured way. Resources were developed with the following outcomes in mind: the lecturer needed to familiarise herself with the subject material as taught in this particular context, before making any major adjustments to the classes, and continuous preparation of the material by students were required, to ensure that all the material may be learned well. Therefore, for the first module the lecturer made the following assumptions: • Since the NWU implements a Sakai-based learning management system (LMS), eFundi, its use was paramount. It was decided that it should be used as much as possible to facilitate the teaching of the subject modules. • To motivate students to prepare for class, class tests should be written before a class is offered. Class tests are followed up to determine the knowledge of the class before a class is offered. • To ensure continuous learning, each study unit should have an accompanying assignment. • To facilitate students' capability to apply learned concepts in a practical setting, a weekly class work activity was planned. This initiative had to serve a number of purposes, such as applying theory in a case study environment, performing activities which are dependent on peers, and supporting the project implementation. • Project groups should only be started after the class had an opportunity to form relationships with peers. After the formation of projects teams, students should be encouraged to work on their projects weekly. Three guiding instruments were planned for the projects: initially a statement of work had to be prepared per group, with the purpose to introduce their projects and group members; after substantial progress was made regarding their projects, groups arranged a consultation session with the lecturer to allow questions to be asked by groups and guidance to be provided by the lecturer; and finally groups would present their documentation and demonstrate their prototype systems.

In support of the subject plan (Figure 3.2) preceding the AR cycles, the learning resources which were relied upon to support students in their endeavour to internalise concepts, with the motivation for the inclusion of each, are listed in Table 3.3.

Table 3.3: Supporting learning resources

<table>
<tr><th rowspan="2">Resource</th><th colspan="2">Description</th><th rowspan="2">Motivation for use of resource</th></tr>
<tr><th>Semester 1</th><th>Semester 2</th></tr>
<tr><td>eFundi as LMS</td><td colspan="2">eFundi is a convenient "one-stop shop" that makes it easier to communicate with students, to assist them in working daily, although students are only in class once or twice per week, where eye-to-eye contact is made.</td><td>eFundi is part of the NWU infrastructure utilised by most academic staff. In SA&D this valuable tool has been utilised since 2011 with the intention to expand its use subsequently.</td></tr>
<tr><td>Text book</td><td colspan="2">The text book is an important resource, because of it contains detailed information; it should be useful to students beyond their studies. For this reason, it is important for students to be able to orientate themselves with regard to the material.</td><td>Although a text book may be perceived as a standard commodity in a university class, this particular text book supply the student with a point of departure. Many useful references are made in the book – to guide students in their future careers.</td></tr>
<tr><td>Slides</td><td colspan="2">Slides are closely related to the text book and summarises the work. This is a resource that is obtained as part of the infrastructure supplied with the text book, made available to students in PDF format, per corresponding outcome topic.</td><td>It has value in guiding the class.</td></tr>
<tr><td>Class test</td><td>A short 5 mark baseline assessment to determine students' pre-knowledge of the material to be covered in class is written at the start of each class.</td><td>A short 5 mark electronic baseline assessment determines students' pre-knowledge of the material to be covered in class is written before each class to inform the lecturer.</td><td>Motivation for students to prepare for class. It also affords the lecturer an indication of students' prior knowledge of the subject matter before it is covered.</td></tr>
<tr><td>Class</td><td>A weekly conventional class is offered to cover each study unit.</td><td>A weekly flipped class encourages students to prepare for class and participate in a class discussion on the topic of the day.</td><td>Being a residential institution students have the benefit of attending classes.</td></tr>
<tr><td>Class work</td><td colspan="2">Class work is a prelude to assignments where practical problems are addressed in groups with the help of the lecturer. No marks are earned and the work is done in an informal atmosphere.</td><td>Since project work is discipline-specific learning in a computing environment, the aim of class work is to practically work with concepts studied – with the help of peers and the lecturer.</td></tr>
<tr><td>Assignment</td><td>Assignments address one or more aspects covered in the week's work in a practical way.</td><td>Assignments address aspects covered in the week's work in a practical way. Two versions are submitted, the first before the class, and the second when all aspects of a SU has been covered.</td><td>With project work being the discipline-specific learning choice of method of SA&D, the aim of assignments are formally implement concepts practically.</td></tr>
<tr><td>Semester test</td><td>Students find semester tests the most difficult part of the assessments. The pressure of learning a large amount of material, to be asked theory type questions, sometimes in combination with real life applications.</td><td>The second semester affords less semester opportunities to allow students more time to prepare, and reminisce on the work.</td><td>A number of formative assessment opportunities are designed to enable feedback opportunities that allow students to prepare for the final examination, and also to build a good participation mark.</td></tr>
</table>

Resource	Description: Semester 1	Description: Semester 2	Motivation for use of resource
Group project	A capstone group project starts early each year and is completed at the end of the year. The first semester's work focuses on systems analysis (to co-inside with the material covered) and the second semester on systems design. Initially groups were made up of three members.	Project work continues in the second semester, and focuses on systems design. If necessary, groups may take in new members.	A group project simulates real life projects and exposes students to group work where they closely work with and rely on their peers.

The instruments which are contributing to the participation mark of the students, are shown in Table 3.4.

Table 3.4: Instruments contributing to the participation mark, per semester

Semester 1	Number	Weight	Semester 2	Number	Weight
Weekly class test	10	10	Weekly electronic class test (10 tests)	10	*0
Weekly assignment	10	10	Weekly assignment, two versions (10 assignments)	10	20
Semester test	2	50	Semester test	1	40
Group project 1. Consultation (5) 2. Final presentation & demonstration (25)	 1 1	30	Group project 1. Weekly presentations (5) 2. Consultation (5) 3. Final presentation & demonstration (30)	 1-2 1 1	40

* It is the prerogative of the lecturer to use the marks – if it is deemed necessary

The subject plan that was initially implemented, is shown in Figure 3.2.

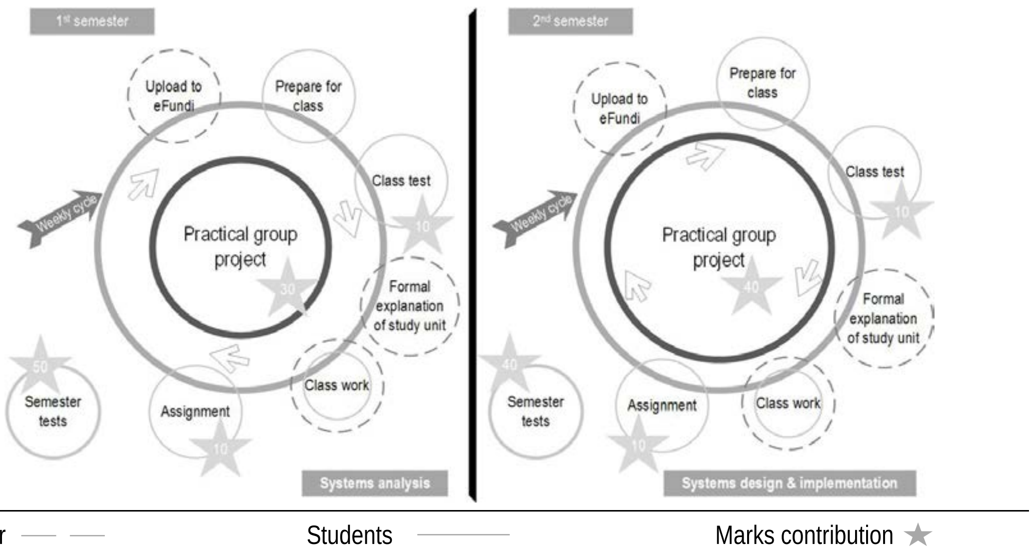


Figure 3.2: Subject plan

The management of the instructional design of teaching and learning in SA&D is directed through the offering of weekly study units, which includes all activities. All resources of this system are indicated with circles. Each weekly cycle starts with the necessary work being uploaded onto eFundi – part of the instructional design environment, and progresses clockwise. Circles with broken lines are showing eFundi uploads or printouts by the lecturer. Solid circles shows activities done by students, either individually or in groups. Semester tests are not written weekly, and therefore is shown separately.

3.5 TECHNOLOGY INSTRUMENTS

The implementation of the three focal points is discussed below. Initially it is situated in its historical context. The discussion of the focal points in the order of their development follows, namely: the Videos, the WhatsApp groups, and the SMARTguides. Lastly the value of the technology instruments are discoursed.

3.5.1 Historical context

Through observation and informally making sense of the educational environment of lecturing SA&D, the researcher determined that students find the subject material of SA&D difficult for a number of reasons:

1. The subject covers a lot of material, which includes a substantial amount of theoretical concepts to grasp, as well as multiple techniques to be applied to various problem situations. Especially at the start of the year this aspect overwhelms students.
2. Learners are prepared to become systems analysts which are *purple people* (Eckerson, 2010). Most learners studying IT are capable technologists, but they do not understand the application environment – they speak blue. People in business know all about their business and the data they need. They can articulate their requirements, but they cannot convert their ideas into a data architecture that will address their needs – they speak red. Therefore a systems analyst should be fluent in purple to facilitate a solution (Eckerson, 2010).
3. The completion of an IS development project is a pre-requisite of the subject, and is completed in groups – with it being the first time in their course that students are exposed to supporting and learning from one another.
4. Being part of the millennial generation, students need to learn in a new, electronic way (Siemens, 2005), while the educational environment tend to disregard this notion.

5. Many students come from disadvantaged backgrounds, which does not support the development of prior knowledge. In some cases students travel long distances to get to campus, do not have access to proper nourishment, and may be isolated while preparing for classes due to lack of funds to access material while off-campus.

Since 2012, in addition to the resources listed in Table 3.3 above, three technological instruments were selected to address the educational purposes identified in Section 3.4.1. Chronologically, the first technology tool identified was that of short videos. Although support existed to allow the recording of lectures for future use, the compilation of short videos on challenging concepts were more alluring. The second technology tool imagined was the use of mobile instant messaging applications (MIMAs), typically associated with mobile devices. The third technology tool ideated was the compilation of an interactive electronic study guides.

In logical order the three instruments address the three educational purposes of instructional design – SMARTguides as interactive electronic study guides, formative guidance – short videos assisting students in learning challenging concepts, and summative assessment – creating MIMA groups in applications such as Blackberry messaging, Mxit, and WhatsApp to guide students while preparing for assessments.

The introduction of the technology tools allowed the implementation of a difference in approach between the two semesters; during the first semester, students are encouraged to come to class prepared to write a class test, the subject material is taught in a formal way, while during the second semester the focus shifts to a reversed classroom and students are prompted to study before they come to the classes for a new study unit commences – by changing the application of three existing class components, namely a baseline test to be written, the first version of the weekly assignment needs to be handed in, and no formal class is offered. The intention of this distinction is to allow students to direct their own learning and to become self-directed learners as they progress through the year. The introduction of the short videos on challenging concepts was designed to support the inversion of the classes, while the existence of the MIMA group, allows students access to the lecturer and their peers. Keeping in mind that most assignments done in the second semester rely on group work, pre-supposes the support of group members. The class components of the two modules are shown in Table 3.5.

Table 3.5: Class component comparison

Component	Motivation for its use in SA&D I	Motivation for its use in SA&D II
eFundi uploads include all material students may need on a weekly basis	The slides per topic, the weekly assignment, class work, as well as feedback on tests and assignments are uploaded on a weekly basis. Students are allowed to see uploaded material one week before class (upon request this may be extended by a few days) to allow students to finish the work of a previous week before they start with the new week's work. This arrangement prevents students from finishing work ahead of time and then not being able to contribute to class work, because they forgot what the work was about.	
Preparation for class	Only a scan of the chapter would be sufficient during the first semester.	More time needs to be spent on pre-class preparation during the second semester.
Class tests, acting as baseline tests.	A 5 mark paper-based test is written at the start of class. A show of hands and informal questions are used to determine the gaps in student knowledge.	A 5-mark electronic test conducted on eFundi the day before class is used to force students to be prepared; and to give the lecturer an indication of which aspects the students struggle with.
Class with formal or informal explanation	Class time is used to teach concepts in depth. This is done at the start of each week. More time is allocated to work identified as difficult.	A few informal questions are posed to students to obtain their interpretation of answers. Depending on the quality of their answers, the first part of the class may be spent building a clearer understanding of involved concepts.
Class work	Class work is used to punctuate important or challenging concepts.	The class work is designed to address issues from each assignment.
Assignments (versions)	Students complete assignments at the end of each week.	Students finish a first version of each assignment the night before class. Although students are encouraged to make this version the final one, they are allowed to hand in an updated version of the assignment the day after class. Each version counts half of the marks allocated. The first version counts the full marks, if no updated version is uploaded.
Practical group project	During the fifth week of the semester, students form groups of 3-6 members and start with their practical group project. The first semester is used to prepare the system's analysis.	Students continue with their projects (in some cases they may re-group) and do the system's design and implementation.
Semester tests	Students write a semester test during the test week and two other tests. Either the semester test or the average of the two other tests count toward the participation mark.	Students write a semester test during the test week and another test. Either the semester test or the other test count toward the participation mark.

The focal points of Videos, WhatsApp groups, and SMARTguides are discussed here.

3.5.2 Formative guidance using videos

The recording of classes did not appeal to the lecturer, mainly because of the fact that classes are typically interrupted, and are offered over longer timeframes of an hour or more – resulting in videos requiring lots of data. Therefore, it was decided to produce short videos on topics students perceive as challenging. During the first year of teaching the subject modules, it was necessary to explain some concepts over and over again – the lecturer and researcher kept record of the concepts explained multiple times in class and during office consultations. A list of challenging concepts were made, and the basic planning to determine how each video should be offered to ensure logical units of video as close as possible to 10 minutes.

A number of examples exist as evidence that the use of videos encourage learning. One example, YouTube, allows informal learning on a topic of one's choice. A more formal example, is the Khan Academy (www.khanacademy.org) developed by Salman Khan. It uses videos to tackle thousands of topics and concepts which are typically included in school, as well as tertiary syllabi. Thompson (2011:2) relates that the duration of Khan-videos are seven to fourteen minutes and are used by teachers and pupils all over the world. Prensky (2011:2) states that the most valuable feature of these videos is that full videos, or parts of videos, may be played numerous times – an action typically happening outside of class time when a student does not slow down the class or reveal his or her ignorance on a topic. Also, the millennial generation, the students of today, are accustomed to using videos as learning tools.

Noer (2012) deems videos to be a cost effective way to train people, a significant finding in an environment where budgets are tight – true in many educational settings. A study conducted by Laine *et al.* (2010:37) found that in the context of technology subjects, video-teaching amends the learning environment of face-to-face teaching. They found that a student can control the progress of his or her own learning, an advantage of using videos.

A purpose of Khan-videos is reversing instruction of classes. When study material, which may be in the form of videos, are made available to students, learning of the basic material before formal classes are conducted, is encouraged. In this context class time is viewed as valuable and therefore not to be used for formal lectures, but reserved to guide homework, allow for one-to-one tutoring, as well as hands-on project work (MacIsaac, 2011). Crouch and Mazur (2001:970) claim that students learn very little through traditional lectures, they need to be actively engaged with study material, which mostly happen when they come to class prepared.

It was anticipated that the creation of the videos would allow students an opportunity to watch a video multiple times, to stop and start as the need arises to watch sections more than once. The video topics cover concepts addressed in assignments, assessments such as semester tests and examinations, and the project to be completed in the subject modules. Some chapters have no supporting videos, while others include more than one – depending on the nature of the work covered. After its production in 2012, videos were made available to students on eFundi to view directly, or download and view. During the first year of implementation much effort was made by the lecturer to make students aware of the existence of the videos and its possible value. A list of challenging concepts, of which videos were made, is shown in Table 3.6.

3.5.3 Preparation for summative assessment using WhatsApp

In many instances disadvantaged students do not have access to Internet and therefore also have no access to eFundi when they are not on campus; they also have limited data for their mobile devices. These realities may isolate students, especially after hours, the time they would have available to prepare for tests and examinations.

Studies that investigated online discussions, highlighted some disadvantages:

- Some participants preferred the face-to-face format of physical interaction to the more limited social interaction associated with an online learning environment (Tichavsky *et al.*, 2015:5).
- With electronic communication seen as a diminished form of conversation, limited flow in dialogue and an absence of non-verbal expression and gestures associated with face-to-face contact, may hamper the impact of discussions (Baym, 2015:57).
- Some participants may be intimidated by having to put their thoughts in writing (Yu, 2018:29).

These disadvantages may be counteracted by the use of emoticons, such as "*:D*" or "😃" to show emotion (Glikson *et al.*, 2018:622), small verbalisations such as "*lol*" (which means "*laugh out loud*") or "*yea*" may facilitate conversational flow and demonstrate understanding. These suggestions may enable the student to build rapport and establish common ground.

An obvious advantage of the use of a MIMA in learning, in the context of this study, is that factors which normally hinder collaboration and group work are minimised when using IM: irrespective of geographical distances, students are able to interact with their lecturers and peers, both synchronously and asynchronously.

Table 3.6: List of challenging concepts of which short videos were made

Semester	No.	Topic	Definition (Bentley & Whitten, 2007)
first	1	Gantt and PERT charts	Gantt chart: a bar chart which depicts tasks against a calendar. PERT chart: a graphical network model which depicts interdependencies between the tasks of a project.
	2	Expectations management	A tool that is used to understand the impact of changing the parameters of a project.
	3	Use-Case syntax	Use case: a business event for which the system should provide a defined response. It evolved out of object-oriented analysis.
	4	Use-Case modelling	The process of modelling a system's functions in terms of its business events: actors initiate events, and the system responds in a defined way.
	5	Data modelling concepts	Data modelling: a technique used to model business requirements to database systems that would fulfil those requirements. Entity relationship diagrams are frequently used to represent data models.
	6	Drawing a data model from a case study	
	7	Data analysis (normalisation)	A technique used to reduce redundancy from a data model in preparation for implementation as a database.
	8	Process modelling concepts	Process modelling: a technique used to organise and document a system's processes in relation to the data stored. Data flow diagrams are frequently used to represent process models.
	9	Process modelling strategy	
	10	Data-Process-Location matrixes	Data-to-location CRUD matrix: a table used to map data requirements to the locations at which they must be stored: it shows which location has what type of access to attributes. Data-to-process CRUD matrix: a table used to synchronise the data and process models of an IS: it shows whether processes need to be restricted regarding the attributes they may access. Process-to-location association matrix: a table used to map processes to the locations at which they must be executed. CRUD: create, read, update, and delete. Submission (S) of data, and no access (X) is implied.
	11	Object modelling concepts	Object modelling: a technique which merges the data and process concerns into singular constructs called objects.
second	12	Cost-Benefit analysis	Cost-effectiveness is a status obtained by balancing the lifetime costs of developing, maintaining, and operating an IS with the benefits derived from it. Cost-benefit analysis is a tool to measure this balance.
	13	Physical process modelling concepts	Physical process modelling: a technique used to model the technical implementation processing characteristics of an IS.
	14	Physical data modelling concepts	Physical data modelling: a technique used to translate business user requirements into a model that depicts its technical implementation.
	15	Database capacity calculations	Ensuring that sufficient disk space is made available to a new IS, the database administrator need to know an estimation of its disk capacity usage.
	16	Graphical User Interface (GUI)	An interface with the user which includes graphical components, such as buttons, icons, and windows.

The use of mobile devices appealed to the lecturer. The idea of a device that is always accessible to students presented mobile phones as a tool they may use to support academic success. During the first semester of 2012 a MIMA was introduced to support students. Students were requested to indicate the platform they already use to socialise, and based on popularity among students, platforms were utilised. These included BlackBerry Messenger (BBM), a South African application called Mxit, and WhatsApp – in order of preference. With only 15 members allowed per group, two BBM groups resulted, and one each on Mxit and WhatsApp.

Groups were formed according to the restrictions prevalent to each platform, and the number of students according to platform preference. The lecturer created groups from information supplied by students. Participation worked on a voluntary basis. Students were invited to join at any time and they could delete the conversation at any time. In addition to the voluntary basis on which the interaction worked, technology is not stable: cell phones break, they get stolen and, especially in the early days, upgrades left one with a virgin MIMA tool with all groups and conversations lost.

Students were prepared that they were supposed to help one another, although the lecturer would clarify issues when she felt students went astray.

The next year, 2013, saw a shift in the student body under discussion regarding their MIMA use. It was noticed that Mxit lost its popularity among the students with only one student using it, and although BBM was still popular, all students using it also used WhatsApp. This situation called for a decision to only use WhatsApp – which allowed groups of up to 50 students at that time. This decision was supported by two aspects associated with the other two IMs:

- Mxit made use of advertisements to supply an income stream – a model that can distract attention from the work at hand,
- BBM allowed students to choose a pseudonym – which made it difficult for the lecturer to identify the person speaking, and
- BBM was also only supported by a BlackBerry phone in the initial years – requiring the lecturer to also use a BlackBerry.

The lecturer felt that WhatsApp was accessible by all smartphones, it focused on conversations only, it supported the sending of pictures to support conversations and it was easy to identify students.

Students could become part of a group by supplying their cell phone number at the start of the academic year. In addition to the groups, a new group was formed after the first examination was written at the end of each semester – the NWU allows for a second opportunity examination for students not able to write the first examination, or failing it.

3.5.4 Instructional design using SMARTguides

The SA&D study guides were designed and developed during 2013 and implemented at the start of 2014. The electronic guides were coined SMARTguides with S-M-A-R-T representing the goals set by the team of lecturers and support staff involved in the first implementations of SMARTguides. This representation is found in Table 3.7.

Table 3.7: The S-M-A-R-T acronym

Letter	Meaning
S	Student-centred Self-directed learning
M	Learning Management enabling the achievement of all self-learning outcomes
A	Assessment is easily integrated with Access to knowledge
R	A Responsive environment is created, that provides for Remediation and Revision of content
T	Learning may be Tracked, measured, collected, analysed , and reported on

With regard to weekly study unit guidance, the subject plan was kept in mind in Table 3.8. Weeks follow the same basic structure.

Table 3.8: SMARTguide contents covered per study unit

Tab	SMARTguide topic	Systems analysis and design I	Systems analysis and design II
1	Overview	Firstly an overview of the chapter to be covered is supplied. Students also get an indication of how long the study unit work should take to complete.	
2	Outcomes	The outcomes guiding the topics covered and assessed are listed.	
3	Guidance	This may refer to one or more videos or additional material uploaded on the LMS. In some cases a page guiding students on what to do in preparation for class, is displayed.	Assistance that may be available in the form of a video or some additional material uploaded on eFundi.
4	Self-assessment	A weekly self-assessment test is included.	
5	Weekly test	Students are reminded that they will be writing a class test in the theory class. They are guided on how to prepare for the test.	Students are reminded of their baseline test to be written on eFundi.

Tab	SMARTguide topic	Systems analysis and design I	Systems analysis and design II
6	Class preparation and feedback	Some study units require students to prepare material from sources other than the text book, they are informed of what needs to be prepared and reminded to bring their class preparation to class. Students are also reminded to look for feedback after class.	Students are reminded of what will be discussed in class, as well as a class discussion document uploaded on the LMS. Students are also reminded to look for feedback after class.
7	Class work	Students are reminded to drop completed class work in their LMS eFundi Dropbox. Any questions that they still might have must be written down – to ensure that they are asked during the follow-up class.	Students are reminded to drop completed class work in their LMS eFundi DropBox. Any questions that they still might have must be written down – to ensure that they are asked during the theory class. This page also focuses on the weekly project presentation. The basic rules are stated to ensure that students are well informed.
8	Assignment	The focus is on the assignment to be handed in at the end of each week in which a study unit is covered.	Students are reminded to upload both versions of their weekly assignment.
9	Practical group project	The work covered in the study unit is then linked to what should be done in this regard in the group projects.	

During the first semester, the theory class is followed by a practical class (class work) on a subsequent day. The theory class covers all outcomes in a formal presentation, while the practical class allows for time to address questions students may have regarding the concepts covered, as well as the assignment or their practical group project. Students are expected to come to class prepared. To test this, a baseline test is written when the theory class commences. During the second semester both the theory and practical classes are scheduled on the same day (back to back, if possible). This time is used to do class work that addresses issues regarding the work covered, the assignment completed on aspects of the work covered, as well as the implementation of the work in the practical group project. Students need to prepare for class beforehand, because the baseline test is written before class, the first version of their assignment is handed in before class, and no formal class is offered.

3.5.5 Value of the implementation of the three focal points

The intention with the introduction of the three technological instruments was twofold: to expand the resources available to students in their preparation to become information system development specialists; and to establish the educational purpose of each technological instrument. In the event of the introduction of the technological instruments the educational themes of formative guidance, summative assessment, and instructional design presented themselves. The introduction of short videos on challenging concepts formed the basis for the educational purpose of reversing classes, which supports self-directed learning. The formation of MIMA groups facilitated the educational purpose of students using their already existent mobile devices to learn from peers and have the support of their lecturer when they prepare for assessments. Lastly, the development of interactive electronic study guides created the opportunity for the third academic purpose of adding a study guide to the mobile device in the hand of students.

This sub-section reminisce on the value of the three technological instruments introduced. Throughout the introduction of the tools, the fact that only the interactive electronic study guides are the only technology tool designed for its purpose, is kept in mind: a MIMA is not designed to be utilised as a teaching and learning tool – but rather for socialising, and the traditional use of videos is in a much broader context – although they do have some record as a teaching tool. Evidence is not conclusive, but rather aim to establish that students value the use of the three technology tools. It is also accepted that, especially in the case of IM, the evolution of the tools, the size of groups, and the composition of a particular group may pose specific challenges. It is anticipated that the guidelines posed as outcome of this study, will guide future implementations.

Formative guidance: as mentioned earlier, the lecturer kept record of the challenging concepts which required re-occurring explanations in class and during office consultations. An encouraging result of the implementation of the videos, when compared to the first two semesters, students grasped challenging concepts without additional explanations from the lecturer. During the first year of implementation, tracking the utilisation of the videos by students supported its value. This is reflected in Table 3.9.

Table 3.9: Views per video during 2012

Semester 1		Semester 2	
Video topic	Views (2nd semester)	Video topic	Views
Gantt PERT	226 (5)	Cost Benefit Analysis	153
Expectations management	215 (6)	Physical process modelling concepts	100
Use-case syntax	142 (7)	Physical data modelling concepts	83
Use-case	141 (5)	Database capacity	142
Data modelling concepts	141 (7)	GUI	94
Data model of case study	146 (7)		
Normalisation	150 (9)		
Process modelling concepts	118 (7)		
Process modelling strategy	122 (7)		
Data Process Location matrixes	134 (7)		
Object modelling concepts	94 (8)		
TOTAL	1629 (75)	TOTAL	572
82 students in class 1 student did not view any videos		69 students in class 6 students did not view any videos 9 students viewed 1st semester videos	
AVERAGE VIEWS (1629/81/11)	1.82 views/student	AVERAGE VIEWS (572/63/5)	1.81 views/student

eFundi, the LMS used in this study, allows for the collection of statistics regarding number of views of videos per student. This data does not distinguish between a view that was started, but not actually watched by the student. In addition it does not keep track of how many students viewed a video with a friend. Furthermore, it also does not count video views by students who downloaded videos and watched it offline. Although the statistical data do not give a perfect count of video watches, it does indicate the usefulness of these videos.

Results shown in Table 3.9 demonstrate that students were slightly more reliant on videos during the first semester with 1.82 views per video, when compared to the second semester with 1.81 views per video. Multiple views by some students for both semesters concur with literature (Prensky, 2011:2). More students viewed videos during the first semester with only one student not viewing videos, compared to six students choosing not to view videos during the second semester. From the lecturer's own observation, more work is covered during the first semester than in the second semester. First semester work is also newer to students and covers more theory. In addition, the lecturer observed that students evolved from being unsure in the first semester to bold and full of confidence at the end of the second semester. Bearing this in mind, it is encouraging to see that 9 students, with 75 views among them, revisited the first semester videos during the second semester.

Since 2014, with the implementation of the SMARTguides, videos were embedded in each SMARTguide, and therefore not allowing tracking of views. Also, since 2013, videos were not promoted vigorously, since it was felt that it should take its rightful place among all other instruments that supports learning.

Summative assessment: for the purpose of valuation, the communication in a WhatsApp group created for the second opportunity examination of the first semester of 2013, are analysed. The group was fairly small – it consisted of 18 students, but was made up of a group of students motivated to pass the subject module. This second opportunity examination group was created on 2 July 2013, the examination was scheduled for the afternoon of 5 July 2013 and the group dismantled on 14 July 2013, after the results for the examination became available. It included close to 400 conversation lines.

The timeline of the existence of the WhatsApp group included the following events:

- The **formation** of the group by the lecturer. The group is named and a group photo that may be changed by any participant is uploaded. The students are prepared regarding the purpose of the group. Missing members are named to enlist the help of members present in getting them on the group.
- **Administrative issues** were addressed in the group. Issues addressed, included arranging a face-to-face examination preparation session and clarifying the purpose of the second examination.
- Establishing the **scope** of the paper. Although the scope of the paper includes all the subject module outcomes, allowing students to speculate on the chances of a question being asked may help them to enter the examination being more confident.
    - In accordance with the purpose of the WhatsApp group, six **topics** were discussed, of which the longest covered almost 135 conversation lines. They included the following: expectation management, Gantt charts, object-oriented analysis, use-cases, cross life-cycle activities, and entity relationship diagrams.

- To **unwind** from the pressure of the examination, directly after the examination. Four members left the group immediately after the examination was written. The rest stayed on to talk about the experience of writing the examination and to keep tabs on the progress regarding the assessment. Most students left the group after their marks were made available.

These categories may be compared to the work that was done by Timmis (2012:10). In the context of IS courses, personal conversations among students were analysed. Two subject groups employing group work were researched – to investigate the informal and invisible support structures amongst students. Four conversation types were identified, namely:

1. A shared understanding and the construction of meaning, where peers converse for the purpose of establishing common ground.
2. Displays of intimacy and making fun for the purpose of building relationships.
3. Labour division in the creation of artefacts (or answers) – something that was found to be common in this research, especially close to assignment deadlines.
4. Sharing of feelings regarding work completed, their lecturer(s) and peers.

When comparing the two scenarios, it is noted that:

- The first two conversation types (points 1 & 2) were almost absent in the SA&D examination preparation conversations. This may be because of the fact that these students worked together in groups and knew one another quite well when the group was formed at the end of the first semester.
- Labour division (point 3) did occur during the discussion of topic 2, but only since it was initiated by the lecturer. A possible explanation for the reluctance of students in this regard, is the difference in context. In the case of the SA&D group, not tangible end product (such as an assignment as was the case in the Timmis-study) was due, and therefore the discussion of the six topics mentioned earlier that occurred, which was most encouraging.
- Sharing of feelings (point 4) occurred after the examination was written – when students speculated on their chances of passing.

The WhatsApp group included 15 students. This supports the claim that the students were motivated to do what was necessary to pass the module. Only nine students actively participated in the discussions. The other six students only "*listened in*" and did not contribute. Of the nine students who interacted, four students participated by using the forum only to solve administrative problems. One student only participated while the scope was discussed. The WhatsApp conversations included the discussion of six topics among the lecturer and four students who made meaningful contributions.

Instructional design: in an attempt to learn the study guide preferences of SA&D students, the 2017 intake were asked to relay their exposure to and experience with the types of guides utilised by the NWU, namely SMARTguides, printed study guides, and eGuides (referring to Lessons – an extension of eFundi). In addition, three questions asked to determine students' study guide preference(s) by focusing on how students prefer to access study material while in class ("*how do you prefer to access study material when you are in class?*"), not in class, but on campus, ("*how do you prefer to access study material when you are not in class, but on campus?*"), and while they are preparing while off campus ("*how do you prefer to access study material when you are in class?*").

Firstly, the researcher determined the exposure students had to the variety of study guidance tools, as offered by the NWU. The question included the options of SMARTguides, printed study guides, and eGuides. Students could select any combination. As indicated by the percentages shown in Table 3.10, students used all types of instruments in their studies with their highest exposure to SMARTguides and the lowest to eGuides.

Table 3.10: Exposure to study guidance tools

Type of guide	Responses
SMARTguide	79 (43%)
Printed guide	59 (32%)
eGuide	46 (25%)
Exposure	184 (100%)

From the responses regarding student preferences, a number of observations may be made.

- In all instances students rely much on access to eFundi, while the declined reliance when off campus and to a lesser extent – on campus, but not in class, emphasizes student dependence on the campus infrastructure.
- Although there is a decline in the dependence on eFundi while in and out of class, but on campus, it is noted that reliance on electronic access makes up for this decline.

- Reliance on printed material becomes higher when students move off campus.
- SMARTguides are listed most (27 times), as opposed to (printed) study guides (21 times), and eFundi eGuides (8 times).

These observations are made, while keeping in mind that students are ensured of having access to state-of-the-art devices and the Internet in class, have possible access to the same devices, or their own device combined with Wi-Fi access to the Internet while not in class, but still on campus, and are dependent on their own devices and data availability when off campus.

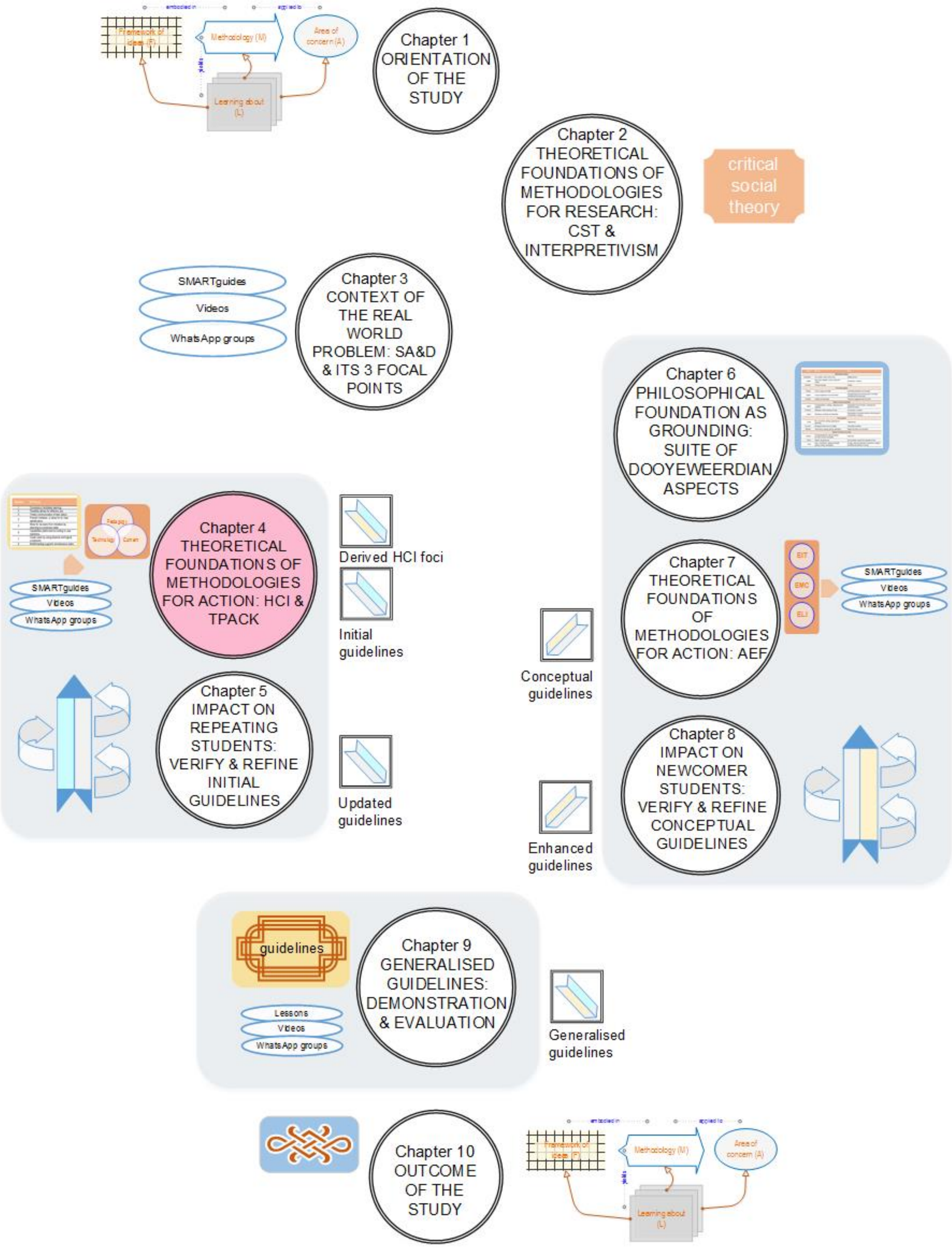
3.6 SUMMARY

The purpose of this chapter was to place this study in the context of SA&D, and to show how the incorporation of three technology instruments included as three focal points of this study, are set in the educational tertiary landscape of South Africa. It addressed the first reflective objective (R01). This was done in the context of the overarching objective of this study; to gain an understanding of the use of technology in an educational setting, with the principles guiding HCI, as focus.

Systems analysis and design, with its two modules, was introduced. The three focal points of this study are instructional design (SMARTguides), formative guidance (videos), and summative assessment (WhatsApp), form a golden thread throughout.

In the subsequent chapter, the literature review of human computer interaction (HCI), with the focus on HCI principles, as well as the framework for technological pedagogical content knowledge, which intersects technology with pedagogy and content as is the case in the context of this study, is done.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



4 THEORETICAL FOUNDATIONS OF METHODOLOGIES FOR ACTION: HCI & TPACK

4.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education, based on human computer interaction principles, from a Dooyeweerdian perspective.

In order to achieve this primary objective, this chapter addresses the second theoretical objective (T02), namely to enquire into the integration of technology into teaching and learning to enhance academic success. The human computer interaction principles are used as guiding lens, while the framework for interaction of technological pedagogical and content knowledge is investigated in support of the human computer interaction principles. In addition, the second reflective objective (R02) is also addressed by obtaining a list of derived human computer interaction foci, and applying the framework for technological pedagogical and content knowledge (Mishra & Koehler, 2006) to it to obtain initial guidelines for this study with regard to the three focal points identified.

In the subsequent sections, the focus of this chapter with regard to the expanded elements that are relevant to this study, is discussed (§4.2). Then human computer interaction is introduced, with the focus on human computer interaction principles (§4.3). The work of Mishra and Koehler (2006), suggesting the technological pedagogical and content knowledge framework, is discussed next (§4.4). Initial guidelines are compiled from the literature, in the context of the three focal points (§4.5). A summary concludes the chapter (§4.6).

4.2 ELEMENTS RELEVANT TO THIS STUDY

The refinement of the Checkland and Holwell (1998b:23) model is shown again in Figure 4.1. The focus of this chapter is to direct the problem-solving process through the use of a methodology, regarding the area of concern. Therefore methodologies (M) are discussed, including human computer interaction (HCI) principles, and the technological pedagogical and content knowledge framework (TPACK), addressing M_R.

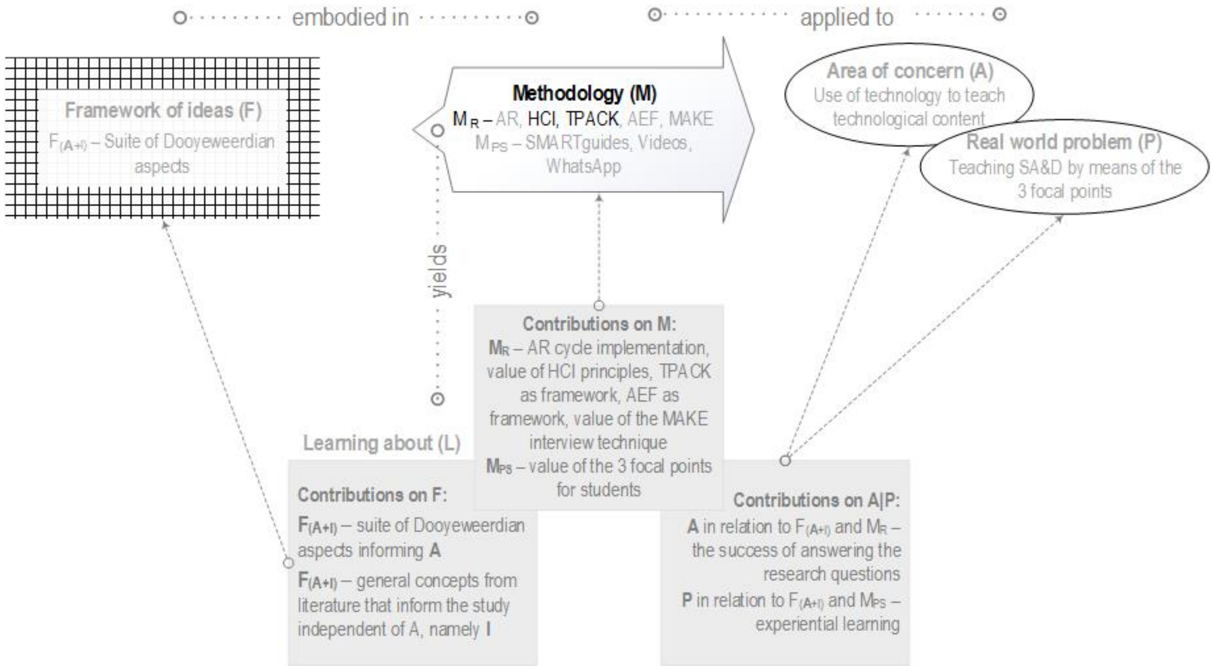


Figure 4.1: The elements relevant to this chapter

The output of this chapter is initial guidelines for the use of technology, which incorporates the three focal points of this study, and is aimed at the problem in the area of concern (A).

4.3 HCI

Myers *et al.* (1996:795) define HCI as follows:

> *"...the study of how people design, implement, and use interactive computer systems and how computers affect individuals, organizations, and society. This encompasses not only ease of use but also new interaction techniques for supporting user tasks, providing better access to information, and creating more powerful forms of communication. It involves input and output devices and the interaction techniques that use them; how information is presented and requested; how the computer's actions are controlled and monitored; all forms of help, documentation, and training; the tools used to design, build, test, and evaluate user interfaces; and the processes that developers follow when creating interfaces".*

HCI guides the designer regarding how to design computer implementations, as well as how the users of these systems will use them to enhance their work; and in the case of this research, their teaching and learning. Dix *et al.* (2004:5) are in agreement with the above quotation when they identify the three important issues studied in HCI, namely; (1)

people or users, who use (2) technology (generally computers), to do a job that normally includes (3) tasks to be performed. When a system supports a user in performing tasks, a last focus emerges – the (4) usability of a system in the context of a user performing a task. A system's usability is important when designing the user interface, which one of the five layers of IS application (Bentley & Whitten, 2007:484), it allows dialogue between the system and its user (Löwgren, 2001:32).

The usability of a system is linked to its usefulness, where a system should do a required task, as well as its use, where a number of people should want to use a system because of its appeal (Dix *et al.*, 2004:5). Technology should therefore be designed to accommodate users who have specific actions to be performed and to facilitate this in a seamless way (Dix *et al.*, 2004:2). Usability has traditionally been the main focus of HCI, where this narrow focus shifted in recent years to the user's experience to currently accommodate technology advancements (Rogers *et al.*, 2011:18). Hassenzahl and Tractinsky (2006) identify three aspects associated with the user experience, namely (1) moving away from the task oriented focus to accommodate a holistic approach which includes the aesthetic as well to allow self-improvement, (2) reflecting the emotional and affective, and (3) the experience the user has when interacting with a system.

4.3.1 HCI principles

Both Dix *et al.* (2004:5) and Hinze-Hoare (2007:12) recognize that HCI theories are not fully developed and focused. This allows for many approaches to HCI and a number of HCI principles sets being widely accepted. This may be due to the fact that the context in which HCI is applied should direct its application.

The eight golden rules of interface design suggested by Shneiderman (1992), ten heuristics for interaction design compiled by Nielsen (1994), the seven fundamental principles of design formulated Norman (2013:72), and the extended set of principles to support usability suggested by Dix *et al.* (2004), are discussed below. The purpose of this discussion is to obtain HCI foci derived from extant literature (§4.3.3), and apply the derived HCI foci to the three focal points (§4.3.4).

4.3.1.1 Interface design rules

Shneiderman (1992:60) suggests eight golden rules of interface design and evaluation of artefacts which summarises the principles to be integrated with others from extant literature:

- *Rule 1*: *Consistency* is important, whether with regard to layout, the use of commands, or the use of terms.
- *Rule 2*: *Shortcuts* such as abbreviations, key combinations, or macros should be provided to enable the speedy performance of familiar actions; especially to frequent users.
- *Rule 3*: *Feedback* informing the user of the status of the artefact should be supplied upon each action performed.
- *Rule 4*: Upon completion of a task, the artefact *dialogue* should relay a message of closure.
- *Rule 5*: *Error prevention* should be a priority, but should a user make a mistake *error handling instructions* should be clear and simple to enable recovery.
- *Rule 6*: *Allowance for the reversal of actions* should be made to allow users to return the artefact to a previous state – it encourages users to explore the artefact without becoming anxious of the outcome.
- *Rule 7*: *The user should be in control of the artefact* and it should respond to the user's actions.
- *Rule 8*: Special care should be taken *not to overload the user's short-term memory* – time should be allowed to learn sequences of actions and displays should be kept simple.

4.3.1.2 Interface design heuristics

Nielsen (1994:30) developed ten heuristics that are intended to be used in interface design and evaluation of artefacts. Nielsen call these general principles heuristics because of their nature; they are not specific, with broad guidelines in the design of interaction. The ten heuristics include:

- *Heuristic 1*: *Dialogue should be relevant and simple* since irrelevant information distracts the visibility of relevant information.
- *Heuristic 2*: *The language used* should be non-technical and familiar to the user.

- *Heuristic 3*: *Memory load should be considered* – the user should be expected to remember very little; if need be, help should be provided.
- *Heuristic 4*: *The consistent use of actions and words* – it should have the same meaning throughout the artefact.
- *Heuristic 5*: *Users should get relevant feedback* regarding what is happening in the artefact.
- *Heuristic 6*: When errors are made, *the artefact should allow "emergency exits"* to allow the user to return to a previous state.
- *Heuristic 7*: Quicker interaction supplied to expert users (and hidden from novice users) through *shortcuts*.
- *Heuristic 8*: *Error messages* should be provided in a simple and clear way to help the user to identify a mistake and to solve the problem.
- *Heuristic 9*: *Error prevention* through thrifty design.
- *Heuristic 10*: Although a well-designed artefact should be used without *documentation*, it should be handy, task-focused, and solution-driven when help is needed.

4.3.1.3 Design principles

Norman (2013:72) formulated seven fundamental principles of design:

- *Principle 1*: *Users' knowledge should be supported*; although users increase their effectiveness in using an artefact by learning its tasks, the information needed to complete tasks should be supplied explicitly or implicitly through imposed constraints to help build a mental model of tasks to be completed.
- *Principle 2*: *Tasks should be structured as simple as possible while keeping the locus of control with the user*; techniques to simplify tasks include providing assistance in breaking composite tasks up into steps, providing information and feedback on a task, automation of a task or part of it, and changing the nature of a task.
- *Principle 3*: *Increase visibility*; it should be clear to a user what the artefact is capable of, how to utilise its capabilities, and what the outcome of user actions are.
- *Principle 4*: *Map user intentions to artefact capabilities*; it should be easy for the user to see the capabilities of the artefact, as well as its corresponding effect.
- *Principle 5*: *Guide users by utilising the power of computers*; physical constraints (such as the size of a screen) and logical constraints (where a scroll bar and incomplete

information on a screen guides a user to scroll down) may be used to guide users to complete tasks.

- *Principle 6*: *Anticipate errors in the design*; design the artefact to anticipate mistakes as well as how to recover from them.
- *Principle 7*: *Standardise key controls*; standardisation require users to learn mappings only once.

4.3.1.4 Principles to support usability

Dix *et al.* (2004:260) supply an extended set of principles to support usability which are divided into three main categories, including learnability, flexibility, and robustness:

- *Learnability* as a category is concerned with features that allow a novice user to negotiate effective interaction and quickly move towards a high level of performance – the focus is on features available to the interactive artefact (Dix *et al.*, 2004:260). Predictability, synthesisability, familiarity, generalisability, and consistency are categorised as learnability principles.
  - *Predictability* as a principle starts from the premise that users should not be surprised; therefore the user's past experience with the artefact should guide future interaction (Dix *et al.*, 2004:261). It supports the fact than human recognition transcends human recollection (Dix *et al.*, 2004:262). Degrees of predictability can be identified; where the highest degree would require the user to remember nothing in addition to displayed information and the lowest degree of predictability would be to require the user to remember all interaction information to be able to determine future interaction consequences (Dix *et al.*, 2004:261). Kristoffersen (2008:263) stresses the fact that a change from one state to another should be communicated, in such a way that the user may judge the system response to an action. Dix *et al.* (2004:261) highlight the fact that predictability used in the context of an interactive artefact should be distinguished from the deterministic performance of a computer system – since predictability is centred on the user, the outcome is also determined by the user.
  - *Synthesisability* refers to the building of a mental picture of the artefact's behaviour which is dependent on the ability of the user to learn the effect of past actions on the current state. Predictability presumes that the user forms a mental picture of the artefact's behaviour which helps to predict its future behaviour, but it says

nothing about the formation of the mental picture (Dix *et al.*, 2004:262). This criterion is the inverse of predictability (Kristoffersen, 2008:263), and to facilitate learning, the user should be able to see changes. Unfortunately, as is the case with predictability, tracking states may lead to a cluttered interface (Kristoffersen, 2008:263). The artefact should display the principle of honesty by providing information on such changes. Degrees of honesty may be identified; where the highest degree would result in immediate feedback occurring without any prompt from the user and the lowest degree of honesty would be feedback shown eventually when explicitly requested by the user (Dix *et al.*, 2004:262).

 - *Familiarity* is concerned with the user's first impression of the artefact, and whether the user knows how to initiate interaction with the artefact (Dix *et al.*, 2004:264). The user's experience with real world and electronic artefacts may help to make the new interactive artefact more accessible to the user. Kristoffersen (2008:264) warns that real-world experiences by users are vast, and therefore a priori knowledge is unspecifiable, making imitation difficult.
 - *Generalisability* extends the familiarity principle and suggests consistency within one artefact or across different artefacts, where it is possible for a user to use past interaction experiences in a new context (Dix *et al.*, 2004:264). Defining generalisability relies on abstraction, as described in object-oriented programming, meaning we categorise in a sensible way with the purpose to group action-response pairs coherently (Kristoffersen, 2008:263).
 - *Consistency* requires situations that are alike resulting in similar behaviour (Dix *et al.*, 2004:264), in a familiar way (Kristoffersen, 2008:263). When it comes to HCI principles, consistency would be the one mentioned most, but it represents multiple properties which makes it difficult to satisfy (Dix *et al.*, 2004:265). Some of the other principles are specified examples of consistency; familiarity may be considered consistency with regard to possible past experiences, while generalisability may be consistency within an artefact or across artefacts. In a general sense consistency refers to the intention of input given or output received on a conceptual level (Dix *et al.*, 2004:265).

- *Flexibility* as a category focuses on making numerous ways available to the user to interact with the artefact (Dix *et al.*, 2004:266). Dialogue initiative, multithreading, task migratability, substitutivity, and customizability are categorised as flexibility principles.

- *Dialogue initiative* as a principle, assumes interaction between a user and an artefact to be a *conversation*; with one of them taking the initiative (Dix *et al.*, 2004:266); when the artefact initiates dialogue and the user responds, it is called system pre-emptive and when the user initiates dialogue upon which the system responds, it is called user pre-emptive. From a user's point of view, the former would be less flexible, whereas the latter would be favoured since it prefers flexibility. In the context of education where the student-as-user should determine the order of progress, a user pre-emptive dialogue initiative would be preferable – to allow for maximum flexibility.
- *Multithreading* supports interaction of simultaneous tasks, with a dialogue thread being a dialogue (sub)set with a common purpose such as a task the user needs to perform (Dix *et al.*, 2004:267). Multimodal dialogue is related to multithreading. Sharma *et al.* (1998:854) posit that humans' interaction is multimodal since we "*speak about, point at, and look at objects*" simultaneously, and typically people would incorporate tone of voice, facial expression, as well as body language to find clues about other people's feelings. We understand our environment through our senses – we taste, hear, look, touch, and smell; opposed to typical human-computer unimodal interaction involving "*typing, clicking the mouse button, speaking, or pointing*" (Sharma *et al.*, 1998:854).
- *Task migratability* involves the passing of control in carrying out a task among the artefact and the user (Dix *et al.*, 2004:268). It may vary between being performed by either the artefact or the user to being shared. A mundane task such as spell-checking may be done by the user, it may be automated by the spell-checker, but it has the best result when the user and the artefact combine forces to accomplish the task.
- *Substitutivity* as a principle, is contributing to flexibility in that the same effect may be acquired in more than one way, depending on which one suits the user at a particular point in time (Dix *et al.*, 2004:268). Substitutivity is relevant to input, as well as output; but the distinction may be vague when input may be used as output or output as input – referred to as equal opportunity (Dix *et al.*, 2004:269). An interface input example of a document's margin may be stated in centimetres or inches, or it may be calculated using a formula; output may be stated as figures, a picture, or a graph may be used; in an equal opportunity case, the length of a user-

drawn line may be calculated, or the user may state its length and the artefact will draw the line.

- *Customizability* refers to how much either the user or the artefact may change the interface. When the artefact initiates a change, it is called "*adaptivity*" and when the user initiates it, it is called "*adaptability*" (Dix *et al.*, 2004:269). From an artefact perspective, the focus is on how it may automatically change its interface to accommodate the user – who may be a novice or an expert. Such changes would be implicit (Dix *et al.*, 2004:270). From the user's perspective, the level of changes may vary between restricting it to repositioning buttons on the screen to an intermediate level where the power given to the user may be increased to allow the user to define macros that may quicken repetitive actions; lastly the user may be allowed to use a programming language to customise the artefact (Dix *et al.*, 2004:269).

- *Robustness* as a category focuses on an artefact that is created to allow users to perform a particular task, or to achieve set goals. It centres around those interaction features of an artefact that enables the accomplishment of the set goals (Dix *et al.*, 2004:270). The principles supporting robustness, namely observability, recoverability, responsiveness, and task conformance are discussed:
  - *Observability* refers to the ways in which an artefact reflect its current state – usually through its interface; allowing the user to match intended actions with the artefact's state (Dix *et al.*, 2004:270). Here, as with the two earlier categories, familiarity and generalisability, Kristoffersen (2008:264) warns against cluttering the interface, and in addition overwhelming the user. He offers browsability, explained below, as a solution. It is closely linked to five sub-principles, namely: browsability, defaults, reachability, persistence and operation visibility (Dix *et al.*, 2004:271):
    - *Browsability* refers to the fact that an artefact's interface usually provides a partial view of the artefact; it is also possible that a task to be completed by the user is not fully observable at once and would require the user to browse (Dix *et al.*, 2004:271).
    - *Default values* supplied by the artefact may be static (defined by the system) or dynamic (computed by the system) and assist the user in more than one way; when the default value is correct, the user is not required to recall the

value, it then also does not require the user to input a value, and it may prevent the user from supplying incorrect data (Dix *et al.*, 2004:271). In addition, a designer may choose not to include a default value (Kristoffersen, 2008:264).

- *Reachability* refers to the ease with which an artefact navigates between states (Dix *et al.*, 2004:271). It has an effect on the artefact's recoverability (discussed next) and influences the artefact's flexibility (a category already discussed).
- *Persistence* addresses the duration of a message the artefact relays to the user and when the user may react to the message (Dix *et al.*, 2004:271). Two examples relevant to persistence, include sound and a visual presentation; a beep sound has a short persistence and needs to be remembered by the user, while a picture such as a flag will stay on the screen until the user removes it – with the effect of acting as a reminder long after it has been sent.
- *Operation visibility* is a special form of the predictability principle (discussed within the learnability category) and refers to how well the artefact shows the accessibility of processes to be executed next (Dix *et al.*, 2004:262). It utilises the fact that people prefer to recognize instead of remember what to do next.

o *Recoverability* as a principle supports the ability of the artefact to allow the user to recover from mistakes made (Dix *et al.*, 2004:272). As with most principles, recovery may be initiated by either the artefact or the user. Artefact initiation focuses on system functionality, while user initiation may be directed backward or forward where the former attempts to remove the effects of an error made by going "*back in time*" to either *undo* mistakes, to *stop* a process executing that may have an undesirable effect, or to *cancel* a process by abandoning it; and the latter expects the user to negotiate unexpected tasks to fix the error that occurred – leaving the artefact in a non-optimal state (Jambon, 1997:3). Kristoffersen (2008:265) reminds us that both forward and backward recovery are instances of reachability. The grouping of state transitions, in this case recognising where a user action start and stop, is a challenge (Kristoffersen, 2008:265).

o *Responsiveness* of an artefact relies on its response time – the time needed by the artefact to relate changed statuses to the user (Dix *et al.*, 2004:272). Immediate responses are the ideal, but when a time delay is necessary the artefact should have a way to let the user know that a request for an action was received and a response is pending. The stability of response time is as important as its speed and refers to how much the time it takes to perform similar tasks, and it varies. Research done by Szameitat *et al.* (2009) highlights the importance of designer sensitivity towards HCI delays, since improved computer power does not resolve responsiveness and delays influence productivity.

- *Task conformance* relates to three desirable aspects of tasks: (1) an artefact is created in a particular context to assist users in executing a task, tasks or to achieve a number of goals set; (2) a natural question following its creation would be whether the artefact corroborates all the tasks it was set out to do – referred to as task completeness, also, whether tasks are done according to the user's expectations – referred to as task adequacy (Dix *et al.*, 2004:272); and finally (3) the ability of the artefact to perform tasks that were not imaginable before its creation.

4.3.2 Integration of design rules, heuristics, and principles

When comparing the rules, heuristics and principles discussed above, some overlap is evident. A mapping of the eight design rules of Shneiderman (1992), the ten heuristics of Nielsen (1994), the seven fundamental principles of Norman (2013), and the multiple usability principles of Dix *et al.* (2004) is attempted. The discussion on the mapping is guided by the order suggested by the design rules of Shneiderman (1992) and supported by the summary supplied in Table 4.1. In doing the mapping eight HCI principles are derived, namely: consistency facilitates learning; flexibility allows for effective use; timely communication of task status; prevent mistakes, or allow for its clear identification; allow for recovery from mistakes by returning to a previous state; capabilities performed according to user intentions; guide users by using physical and logical constraints; and multithreading supports simultaneous tasks.

Table 4.1: Mapping the design rules of Shneiderman (1992), the heuristics of Nielsen (1994), the fundamental principles of Norman (2013), and the usability principles of Dix et al. (2004) onto one another

No.	Named focus; explanation	8 golden rules (Shneiderman, 1992)	10 heuristics (Nielsen, 1994)	7 fundamental principles (Norman, 2013)	An extended set of principles (Dix *et al.*, 2004)
1	**Consistency facilitates learning** (of an artefact); how an artefact links with one's world, its standardisation and consistency, and generalisability across artefacts assists one in learning to use it.	Rule 1: Consistency as aim.	Heuristic 4: The consistent use of actions and words.	Principle 7: Standardisation which require users to learn mappings only once.	Learnability: **consistency**. - Learnability: **generalisability** – consistency within one artefact or across different artefacts (use past interaction experiences in a new context). - Learnability: **familiarity** – first impression of the artefact, directing initiate interaction (real world and electronic artefacts may support accessibility).
2	**Flexibility** (of an artefact) **allows for effective use**; flexibility with regard to changing the interface, or creating shortcuts to allow multiple ways to perform a task.	Rule 2: Shortcuts provided for quick performance of familiar actions.	Heuristic 7: Supply shortcuts to frequent users.	Nothing explicitly listed by author.	Flexibility: **customizability** refers to how much the user or the artefact may change the interface. - Flexibility: the principle of **substitutivity** refers to the fact that the same effect may be acquired in more than one way, depending on what suits the user.
3	**Timely communication of task status**; while an artefact is busy with a task, and upon its completion, prompt, visible and informative feedback should be provided regarding the changing and current state of the artefact.	Rule 3: Informative feedback to the user upon an action performed. Rule 4: Dialogue should indicate closure of a task.	Heuristic 1: Dialogue should be relevant and simple to enhance its visibility. - - - - - - - - - - - Heuristic 2: Language used should be familiar to the user. - - - - - - - - - - - Heuristic 5: Users should get relevant feedback regarding what is happening in the artefact.	Principle 3: Increase visibility; it should be clear to a user what the artefact is capable of, how to utilise its capabilities, and what the outcome of user actions are.	Learnability: **synthesisability** allows the user to build a mental picture of an artefact's behaviour which depends on the ability of the user to see changes (the effect of past actions on the current state). - Robustness: **observability** refers to how an artefact reflects its current state after a user performed an action. - Robustness: the **responsiveness** of an artefact refers to its response time – the time needed by the artefact to relate changed statuses to the user.

No.	Named focus; explanation	8 golden rules (Shneiderman, 1992)	10 heuristics (Nielsen, 1994)	7 fundamental principles (Norman, 2013)	An extended set of principles (Dix *et al.*, 2004)
4	Prevent mistakes, or allow for its clear identification; the design of an artefact should include the anticipation of mistakes with the purpose to prevent errors, but when they occur, error messages should be clear in identifying the mistake.	Rule 5: Make error prevention a priority, but when a mistake is made, instructions to handle errors should be clear and simple.	Heuristic 9: Error prevention through thrifty design. - - - - - - - - - - - Heuristic 8: Error messages should be provided in a simple and clear way to help the user to identify a mistake.	Principle 6 (in part): Design the artefact to anticipate mistakes.	Nothing explicitly listed by author.
5	Allow for recovery from mistakes by returning to a previous state; this focus is linked to the preceding two foci (3 & 4), and therefore it is stated as a separate focus to allow for recovering from a mistake by returning to a pre-mistake state. Instructions to guide the user may be helpful.	Rule 6: Users should be encouraged to explore an artefact – by including measures to allow them to return the artefact to a previous state.	Heuristic 6: When errors are made, the artefact should have a way to allow the user to return to a previous state. - - - - - - - - - - - Heuristic 10: Documentation may come in handy in recovering from mistakes, especially regarding complex actions.	Principle 6 (in part): Design the artefact to indicate how to recover from mistakes.	Robustness: the principle of **recoverability** supports the ability of the artefact to allow the user or the artefact to recover from mistakes made.

No.	Named focus; explanation	8 golden rules (Shneiderman, 1992)	10 heuristics (Nielsen, 1994)	7 fundamental principles (Norman, 2013)	An extended set of principles (Dix *et al.*, 2004)
6	(Artefact) capabilities performed according to user intentions; tasks are performed by the user, through the assistance of an artefact – this means that the initiative migrates between the user and the artefact. It is important that, although the initiative may migrate, that the locust of control should be with the user to ensure that the artefact's capabilities are performed according to user intentions.	Rule 7: The user should be in control of the artefact.	Nothing explicitly listed by author.	Principle 2: Tasks should be simple and keeping the locust of control with the user. - - - - - - - - - - - - - Principle 4: Mapping of user intentions to artefact capabilities.	Flexibility: the **dialogue initiative** principle assumes interaction between a user and an artefact to be a conversation; with one of them taking the initiative. From a user's point of view, the former would be less flexible, whereas the latter would be favoured since it favours flexibility. - Flexibility: the **migratability of a task** involves the passing of control in carrying out that task among the artefact and the user. - Robustness: **task conformance** involves three concepts; an artefact should assist users in executing a task, or more tasks; or to achieve a number of goals set; task(s) or goals should be done according to the user's expectations, and it should have the ability to perform tasks that were not imaginable before its creation.
7	Guide users by using physical and logical constraints; this focus is linked to both foci 1 & 6. Guidance should be provided to the user, with the focus on recognising what needs to be done, instead of remembering it. It is important in the educational context where technology tools may be used to guide students with regards to learning material, rather than learning the tool itself.	Rule 8: Do not overload the user's short-term memory – keep displays simple and allow time to learn sequences of actions.	Heuristic 3: The user should be expected to remember very little; provide help.	Principle 1: Users' knowledge should be supported; information needed to complete tasks should be imposed via constraints to help build a mental model of tasks to be completed. - - - - - - - - - - - - - Principle 5: Guide users by utilising the power of computers; physical constraints and logical constraints may guide users to complete tasks.	Learnability: **predictability** starts from the premise that users should not be surprised; past experience should guide future interaction. It supports the fact than people are better at recognition than recollection.

No.	Named focus; explanation	8 golden rules (Shneiderman, 1992)	10 heuristics (Nielsen, 1994)	7 fundamental principles (Norman, 2013)	An extended set of principles (Dix *et al.*, 2004)
8	Multithreading supports simultaneous tasks, multimodal dialogue include multiple human senses; a task a user needs to perform, should involve a dialogue thread.	Nothing explicitly listed by author.	Nothing explicitly listed by author.	Nothing explicitly listed by author.	Flexibility: **multithreading** supports interaction of simultaneous tasks. **Multimodal dialogue** include multiple human senses.

The table above is extended to extract derived HCI foci.

4.3.3 Derived HCI principles mapped to obtain derived HCI foci

In this section the eight derived HCI principles listed in Table 4.1 are mapped to the list derived by Hinze-Hoare (2007), upon analysing journal articles on HCI models – in an attempt to unify HCI principles as shown in Table 4.2. Since the categorisation of the two lists differs, a one-on-one mapping is not possible. For this reason the mapping is discussed below the table. The position of each principle retained is based on that of the Hinze-Hoare list. This position is based on the citation frequency in the papers included in the study, and weighted accordingly. Although the Hinze-Hoare (2007) study referenced a broader author base, all the authors referenced here, is also included in that study.

Table 4.2: Mapping the eight derived HCI principles to the list of Hinze-Hoare (2007)

No.	Derived HCI principle	Motivation	Hinze-Hoare categorisation	Position (weighted rating)	Explanation
1	Consistency facilitates learning.	How an artefact links with one's world, its standardisation and consistency, and generalisability across artefacts assists one in learning to use it.	Familiarity	2 (57) Note: this is the principle that was most quoted among HCI authors.	The degree to which the knowledge and real-world experience of the user is drawn upon to provide insight into how the artefact works. Familiarity plays a role, especially regarding the first impression of the artefact, which greatly relates to user experience. High familiarity cuts down the time needed to gain new knowledge, reducing the cognitive load.
			Consistency	3 (57)	Consistency, which results from similarity of situations or tasks a person has previously experienced, or done, as well as similarity of the appearance of the artefact, and its behaviour.

No.	Derived HCI principle	Motivation	Hinze-Hoare categorisation	Position (weighted rating)	Explanation
2	Flexibility allows for effective use.	Flexibility with regard to changing the interface, or creating shortcuts to allow multiple ways to perform a task.	Substitutivity	4 (54)	The ability of the user to apply personal preference when entering a value, or utilising different ways to perform an action. A variety of options constitutes input substitutivity, allowing the user choices.
3	Timely communication of task status.	While an artefact is busy with a task, and upon its completion, prompt, visible and informative feedback should be provided regarding the changing and current state of the artefact.	No mapping.		
4	Prevent mistakes, or allow for its clear identification.	The design of an artefact should include the anticipation of mistakes with the purpose to prevent errors, but when they occur, error messages should be clear in identifying the mistake.	Recoverability	1 (96)	The ability of users to recover from inevitable mistakes made. Directions of recovery may be *forward*, which involves the prevention of errors and is part of the design of the artefact, or *backward*, which involves the reversal of errors and is initiated by the user.
5	Allow for recovery from mistakes by returning to a previous state.	This focus is kept separately to allow for recovering from a mistake by returning to a pre-mistake state. Instructions to guide the user may be helpful.			
6	Capabilities performed according to user intentions.	Tasks are performed by the user, through the assistance of an artefact – this means that the initiative migrates between the user and the artefact. It is important that, although the initiative may migrate, that the locust of control should be with the user to ensure that the artefact's capabilities are performed according to user intentions.	Task migratablility	5 (40)	Control for the execution of tasks are transferred between the system and the user. Spell checking is a good example, since it is easy to automate, but the user needs to keep the initiative: to set the language, and to ensure words not included in the electronic dictionary, is also checked.

No.	Derived HCI principle	Motivation	Hinze-Hoare categorisation	Position (weighted rating)	Explanation
7	Guide users by using physical and logical constraints.	Guidance should be provided to the user, with the focus on recognising what needs to be done, instead of remembering it.	Synthesisability	6 (34)	When using the interface, the user should be able to predict what will happen next. From this, the user should be able to scaffold knowledge regarding the artefact.
			Predictability	7 (32)	An artefact should support a user regarding future actions, based on its performance in the past. Pre-knowledge regarding what happens when a particular option is selected, is the result. Such a selection should be predictable and consistent.
8	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses.	A task a user needs to perform, should involve a dialogue thread.	Perceptual Ergonomics	8 (31)	Measuring human perception allows the improvement of computer interfaces for use by humans. Humans perceive their environment through their senses (see, hear, touch, smell, taste). Examples include individuals not perceiving certain colours (in the case of colour blind individuals), or certain audible signals. Designers should remove such colours and pitches from the interface.

From the eight derived HCI principles, seven could be mapped to the Hinze-Hoare list of eight. Although one derived HCI principle does not feature on the Hinze-Hoare list, it is retained for inclusion in this study. Two individual HCI principles are mapped to two on the Hinze-Hoare list respectively, and one on the latter list is mapped to two different HCI principles. The discussion for the inclusion of HCI principles into the derived HCI foci follows, with the numbers corresponding to those used in Table 4.2:

1. *Consistency and familiarity facilitate learning*: Hinze-Hoare (2007) identified two unified principles: familiarity (listed 2nd) and consistency (listed 3rd). When joined, this focus is placed first. Hinze-Hoare (2007) distinguished between these: consistency focuses on an area of application, such as the menu structure, while familiarity relates to a user's personal experience, aligning with the derived HCI principle. The principle description is amended to include the term "*familiarity*".
2. *Guide users by using physical and logical constraints*: Hinze-Hoare (2007) identified two principles: synthesisability (listed 6th) and predictability (listed 7th). When joined, this focus is placed second. Hinze-Hoare (2007) distinguished between these: synthesisability refers to the fact that a user should be able to predict what will happen

next when using a user interface, while predictability refers to future performance of an artefact being predicted by past performance.

3. *Flexibility allows for effective use*: Hinze-Hoare (2007) named a similar principle "*substitutivity*". It moves from the fourth position to the third.
4. *Prevent mistakes, or allow for its clear identification*.
5. *Allow for recovery from mistakes by returning to a previous state*: the research of Hinze-Hoare (2007) combines position 4 and 5 in one principle. It is placed first. When mapped to the derived HCI principles *the prevention of mistakes* are listed separately from *allowing recovery from mistakes*. The division of the principle divides the weighted rating, resulting in positions 4 and 5.
6. *Capabilities performed according to user intentions*: Hinze-Hoare (2007) also places task migratability in position 6.
7. *Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses*: Hinze-Hoare (2007) did not include multithreading, but does include "*perceptual ergonomics*", similar to "*multimodal dialogue*", as seventh and last principle. It incorporates humans as subject of HCI interventions, specifically in terms of sound and colours.
8. *Timely communication of task status*: although Hinze-Hoare (2007) did not include a similar principle, this derived HCI principle is retained as last derived HCI focus.

Table 4.3 is included to show the derived HCI foci – in order of relevance ("position").

Table 4.3: Position of each derived HCI focus after the derived HCI principles were mapped to the Hinze-Hoare (2007) list

No.	Position	Hinze-Hoare categorisation	Derived HCI focus	Explanation
1	1	Positions 2 & 3 with a total weight of 114	Consistency and familiarity facilitate learning.	The familiarity with which an artefact links with one's world, its standardisation and consistency, and generalisability across artefacts assists one in learning to use it.
7	2	Positions 6 & 7 with a total weight of 66	Guide users by using physical and logical constraints.	Guidance should be provided to the user, with the focus on recognising what needs to be done, instead of remembering it.
2	3	Position 4 with a weight of 54	Flexibility allows for effective use.	Flexibility with regard to changing the interface, or creating shortcuts to allow multiple ways to perform a task.
4	4	A shared position 1 with a weight of 48 (96/2)	Prevent mistakes, or allow for its clear identification.	The design of an artefact should include the anticipation of mistakes with the purpose to prevent errors, but when they occur, error messages should be clear in identifying the mistake.

No.	Position	Hinze-Hoare categorisation	Derived HCI focus	Explanation
5	5	A shared position 1 with a weight of 48 (96/2)	Allow for recovery from mistakes by returning to a previous state.	Recovering from a mistake by returning to a pre-mistake state by reversing errors. Instructions to guide the user may be helpful.
6	6	Position 6 with a weight of 40	Capabilities performed according to user intentions.	Tasks are performed by the user, through the assistance of an artefact – this means that the initiative migrates between the user and the artefact. It is important that, although the initiative may migrate, that the locust of control should be with the user to ensure that the artefact's capabilities are performed according to user intentions.
7	7	Position 8 with a weight of 31	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses.	A task a user needs to perform, should involve a dialogue thread. Measuring human perception allows the improvement of computer interfaces for use by humans. Humans perceive their environment through their senses (see, hear, touch, smell, taste).
3	8	No categorisation	Timely communication of task status.	While an artefact is busy with a task, and upon its completion, prompt, visible and informative feedback should be provided regarding the changing and current state of the artefact.

Lastly the derived HCI foci is mapped to the three focal points.

4.3.4 Mapping the derived HCI foci to the three focal points

The eight HCI foci derived through the integration of extant research (§4.3.2) and compared to the findings of Hinze-Hoare (2007), is mapped to this study to determine its value in the context of the research in Table 4.4. The general nature of the three focal points of instructional design, formative guidance and summative assessment is the focus of the table, this may have positive (good) or negative (bad) implications.

Table 4.4: The eight derived HCI foci applied to this study – on the three focal points

Pos	Focus	Interactive electronic study guide application	Video application	MIMA application
1	Consistency and familiarity facilitate learning.	In relation to this focus, a metaphor such as a printed study guide may be helpful when using an interactive electronic study guide; for instance, in an interactive electronic study guide, the left-right arrow keys would direct movement to the next or previous pages, while the next or previous icons may be clicked throughout the artefact.	In its production, similarities in the approach may be useful, for instance, the inclusion of handwritten text, the inclusion of the lecturer compiling the video (audio and possibly video), a pace that allows students to reflect. In addition, while viewing it, a student may stop a video to reflect, or repeat a part that was not clear.	A MIMA allows students the opportunity to communicate, for instance, ask questions, answer questions that was asked, or provide an answer to one's own question and request feedback on the quality of the answer supplied.

Pos	Focus	Interactive electronic study guide application	Video application	MIMA application
2	Guide users by using physical and logical constraints.	Mistakes in an interactive electronic study guide centre on the self-assessment tests where backward recovery is implemented to allow users to easily change the answers they indicated – to correct incorrect answers.	All video players work in similar ways: one may start a video, stop it, rewind it, and fast forward.	In the case of a MIMA such as WhatsApp, the placing of messages are simple, and its use is intuitive. It would be possible to make use of hash tags (such as #SU to indicate a study unit), but then every user needs to remember the hashtag, which makes it less than friendly.
3	Flexibility allows for effective use.	An interactive electronic study guide may be accessed on a variety of platforms, for instance, a LMS platform, on a desktop, laptop, or mobile device. Internal functionality includes options to go directly to particular parts using tabs, or to work sequentially towards an end goal.	Although videos are designed to only be watched sequentially, it is fairly easy to move forward or backward should one want to verify a fact, without watching it once more.	When using a MIMA such as WhatsApp, one may customise the application to adjust its access or use, for instance, one may create a shortcut to the application on one's mobile device, be informed of incoming messages, or link the application to one's desktop or laptop.
4	Prevent mistakes, or allow for its clear identification.	Within an interactive electronic study guide a key or button may be pressed that does not enact the action intended. This is easily rectified by using the back arrow key and pressing the correct key enacting the intended action. Tab keys assist the user in this action by supplying each aspect of a study unit with a handle.	By using either Windows media player, or VLC (VideoLAN Client) media player platforms, users should be able to watch a video from start to finish.	Problems associated with MIMAs occur when updates are not enabled. Mobile device notifications ensure that users are informed to prevent such mistakes. Status indicators assist users in terms of their connectivity position.
5	Allow for recovery from mistakes by returning to a previous state.	It may happen that an interactive electronic study guide becomes corrupted, or deleted. This problem may easily be corrected by re-installing such a guide.	The video platform is not prone to errors, and it is easily downloadable when it has been deleted accidentally.	Until recently, a MIMA such as WhatsApp, did not allow members of a group to delete a message placed accidentally. A recent feature allows deletion of such messages, although the deleted message will be indicated on the group chat.
6	Capabilities performed according to user intentions.	Although a user typically takes control of an interactive electronic study guide, its purpose is to guide the user regarding tasks to be performed on the relevant study unit.	As soon as a video is set up to watch, its sequential nature may be amended, since it is easy to move forward (to skip parts) or backward (to watch parts once more).	Participation (initiation or reply) in a conversation is determined by the user of a MIMA, while the delivery of messages are controlled by such an application.

Pos	Focus	Interactive electronic study guide application	Video application	MIMA application
7	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses.	Although an interactive electronic study guide do not inherently support multithreading, users may utilise such functionality of Windows or Android to access it along with other technology tools on a desktop, laptop, or mobile device. When designing an interactive electronic study guide careful attention should be given to the selection of colour and sound to accommodate human senses.	Although videos do not inherently support multithreading, users may utilise such functionality of Windows or Android to access it along with other technology tools on a desktop, laptop, or mobile device. Augmenting a video with a breakdown structure may aid users in directly accessing a topic in longer videos. Designing videos should accommodate human senses regarding colour and sound.	To a limited extent a MIMA such as WhatsApp allows a user to see multiple messages at once. Users may utilise the multithreading functionality of Windows or Android to access it along with other technology tools on a desktop, laptop, or mobile device. The use of colour is controlled by the application, while sound may be manipulated by the user.
8	Timely communication of task status.	An interactive electronic study guide may guide the user in answering a self-assessment quiz by not allowing a deposit of an incorrect answer when question-answer matches are utilised.	Videos clearly give the viewer an indication of the length of a video and how much time has been spent watching, as well as how much time is left to watch. The aim should be to cover only one topic in a video and do this in as short a timeframe as possible.	When using a MIMA, it may be possible that more than one question are discussed at once. In addition, logistical issues, as well as administrative issues may be discussed. This may prevent users from following a conversation. A recent feature added to WhatsApp, reference to a communication thread, supports this issue.

With the HCI foci extracted, the framework for TPACK interaction, is investigated next.

4.4 TPACK

Mishra and Koehler (2006:1018) posit that it is not enough to only study technology, but also how it would be used in a particular context. Selfe (1990:119) agrees; we need to study technology from a theoretical perspective – to facilitate a broader perspective in terms of the context of a technological application, as well as its social and cultural setting.

4.4.1 A framework for TPACK interaction

According to Mishra and Koehler (2006:1020) "*the understanding that teaching is a highly complex activity that draws on many kinds of knowledge*" forms the basis of their framework; it involves cohabiting *what* people learn with *how* people learn. Unfortunately it may happen that too much emphasis is placed on the one, which is often at the expense of the other. The framework is shown in Figure 4.2 and discussed next.

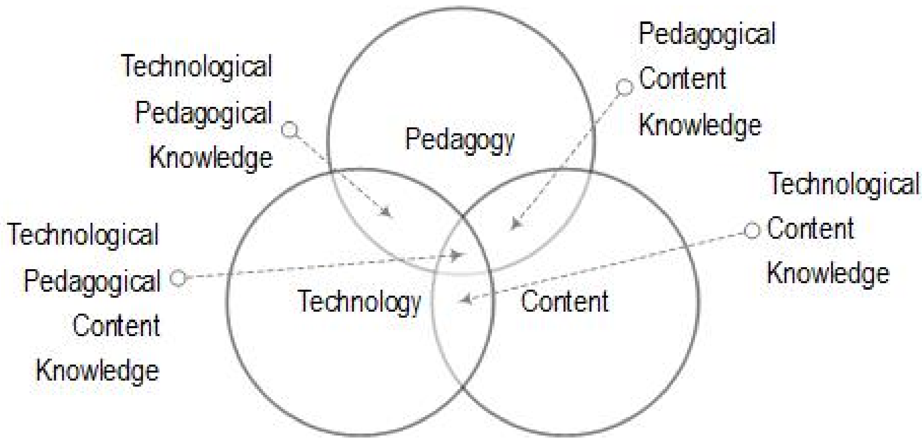


Figure 4.2: Technological Pedagogical Content Knowledge, adopted from Mishra and Koehler (2006:1025)

4.4.1.1 Content Knowledge

Although content knowledge (CK) refers to actual specific subject matter, which may be taught to people to enable them to learn, there is much more involved (Mishra & Koehler, 2006:1027). Shulman (1986) emphasizes that ideas within a field should be organised, as well as connected; while the nature of knowledge and its corresponding enquiry in one discipline may differ from that of another discipline. To be able to facilitate learning in a particular discipline, a lecturer needs to understand these nuances to be able to direct learning in the chosen discipline.

4.4.1.2 Pedagogical Knowledge

Pedagogical knowledge (PK) is cross-disciplinary and involves managing the classroom, planning and implementation of lessons, the learning itself, and the subsequent assessment of learning (Mishra & Koehler, 2006:1026). Mishra and Koehler (2006:1027) continue by adding that lecturers need to keep in mind the purpose and aims of their class, the values to be instilled; they need to know their audience, the techniques that may be of value in their teaching, and strategies to assess learning; and of equal importance is an understanding of how learners[5] construct knowledge and how to motivate these learners.

[5] The terms "*student*", "*lecturer*", "*lecturing*", and "*studying*" are used in the higher education context of South Africa. Mishra and Koehler (2006) work in the context of educating school teachers and use "*student*", "*teacher*", "*teaching*" and "*learning*". In this study, as a general approach, a student is a learner of new concepts. At university a student studies a subject. A lecturer lectures a subject and teaches concepts related to the subject matter.

Pedagogics are beyond the scope of this study, but for the purpose of clarifying learning approaches applied to this study, Table 4.5 lists the learning approaches, each with a short explanation, and the accompanying references.

Table 4.5: Pedagogical concepts relevant to this study

Concept	Short explanation	References
Self-directed learning (SDL)	A process where an individual actively determines his or her own needs in terms of learning new content by: • determining goals to achieve the learning, • identifying resources to facilitate the learning, • choosing the strategies suited for the learning, • managing time needed for learning, and • accomplishing the outcomes set by the learning. This process may occur with the help of others. SDL is associated with adult education.	Knowles (1975) Boekaerts and Corno (2005) Loyens *et al.* (2008) Bolhuis (2003)
Self-regulated learning (SRL)	A process where an individual decides on a learning strategy when learning specific material. Such students are motivated to learn and actively involved in their learning. These skills may be taught, and forms part of SDL. SRL is associated with school education.	Zimmerman and Pons (1986) Zimmerman (1990) Anderton (2006) Bolhuis (2003) Loyens *et al.* (2008)
Problem-based learning (PBL)	An active process in which learning takes place when students solve (real-world) problems; through which they develop strategies, construct knowledge, and reflect on the experience. The responsibility of learning lies with the student. It encourages and supports SDL, and stimulates the development of attitudes and skills needed to work in an environment that is changing constantly, such as the computing environment.	Loyens *et al.* (2008) Hmelo-Silver (2004) Chakravarthi and Vijayan (2010)
Project-based learning (PBL)	Both problem-based learning, and project-based learning are referred to as PBL. The concepts are distinguished by associating the former with a single study unit of learning, while the latter would require the learner to integrate a number of (or all) study units.	Perrenet *et al.* (2000)
Cooperative learning	An approach that requires small groups of students to employ team work to solve a problem. For cooperative learning to work as a strategy, the lecturer becomes a facilitator and not the sole authority of information.	Prince and Felder (2006) Pfister and Wessner (2000)

4.4.1.3 Technological Knowledge

In a time and age where technology became transparent in the world, knowledge about technology (TK) established itself as important in the life of an educator; it is not only useful as a tool to represent content knowledge or do demonstrations, but to use it effectively became necessary knowledge for learners (Mishra & Koehler, 2006:1023). Technology may range from standard, such as using chalk on a blackboard, or a conventional book, to advanced, such as using the Internet or mobile instant messaging applications (MIMAs) (Mishra & Koehler, 2006:1027). For educators to use technology effectively, especially digital technology, acquiring knowledge of computer hardware and software is a necessity (Mishra & Koehler, 2006:1027).

4.4.1.4 Pedagogical Content Knowledge

Addressing the exclusion of the content or the pedagogical knowledge, Shulman (1986:9) invented the notion of pedagogical content knowledge (PCK, shown in Figure 4.2), which exists at the overlap of the two separate spheres representing content (C) and pedagogy (P), shown in Figure 4.2. In essence, this intersection represents the established themes in a particular subject area and how these topics are represented to ensure learners' understanding of them (Shulman, 1986:9). The PCK overlap represents knowledge that a non-lecturing expert of the subject will not necessarily have, as would be the case with an educator who does not know the subject (Marks, 1990:9). This intersection presents discipline-specific concepts using pedagogical techniques, therefore the educator in a discipline would understand which concepts are easy or difficult to learn, how scaffolding of information occurs, and how to involve learners in their own learning (Mishra & Koehler, 2006:1027).

4.4.1.5 Technological Content Knowledge

Technological content knowledge (TCK, shown in Figure 4.2) means that academics know not only their subject, but also how it may be projected through technology – this implies that the one has an influence on the other, and a relation exists between content and technology (Mishra & Koehler, 2006:1028). It is true that technology may restrain current representations, while rapid evolution in the technological world may soon afford increased flexibility.

4.4.1.6 Technological Pedagogical Knowledge

Mishra and Koehler (2006:1028) make us aware that technological pedagogical knowledge (TPK, shown in Figure 4.2) allows the educator to use technology to support teaching and learning – which in turn may change teaching as such. With a number of tools available to support a particular task, each with its unique fitness for purpose and combined with an educator's singular understanding of its implementation, it is expected that lecturing may be changed. Typical areas of support include the following; keeping record of classes and attendance, assessing and grading learners, and LMS messaging and chats.

4.4.1.7 Technological Pedagogical Content Knowledge

In addition to content and pedagogical knowledge, knowledge of technology (T) is becoming crucial for educators. Mishra and Koehler (2006:1023) warn that this latest addition to knowledge used in education complicated rather than simplified the classroom environment, with the technology bubble also gestated to be detached from the content and pedagogy spheres. Since the use of technology to teach may encumber content and how it is represented, it may be dangerous for it to stand alone. We find the compounded interaction of the three knowledges at their intersection (TPCK, shown in Figure 4.2) with the overlapped knowledge stretching beyond the sum of isolated individual content, pedagogy, and technology knowledge. Mishra and Koehler (2006:1029) expanded on the earlier statement of Marks (1990:9); the TPCK overlap represents knowledge that a technologist who does not know the subject matter or lecturing as such will not have as is the case with a subject matter expert adept in technology, as well as a lecturer with little knowledge of the subject matter or technology.

4.4.2 The TPACK model applied to this study

Critically viewing the TPACK model discussion above, its value is the understanding provided regarding the guidelines to be formed. It is followed in order to ensure that the technology tools used to teach and learn SA&D will support the environment. Regarding the anticipated action and direction of the empirical intervention, the researcher needs to anticipate action and direct the intervention based on this knowledge.

The value of TPACK in the context of this study is reflected upon in Table 4.6, by mapping examples from the study – to each of the three spheres and their intersections. The general nature of the study is the focus of the table.

Table 4.6: The implementation of TPACK in the context of this study

TPACK knowledge (assigned meaning by Mishra and Koehler (2006))	Contextual example from the study
Content sphere (Actual and specific subject matter, taught to people to facilitate learning. This facilitation is unique to a particular discipline).	In this study the content of SA&D employs a plethora of approaches and techniques, inputs from stakeholders and phases to ensure a usable system. Approaches are applied in three areas, namely analysis, design, and implementation.

TPACK knowledge (assigned meaning by Mishra and Koehler (2006))	Contextual example from the study
Pedagogical sphere (Cross-disciplinary knowledge involving: how to manage the classroom, plan lessons, implement the plan, handle learning in itself, and assessment. Educators need to keep the purpose of a class in mind, as well as the values to be instilled. They should know their audience, techniques of value in teaching, and strategies to assess learning. Knowledge on the construction of knowledge and the motivation of learners are crucial).	SA&D involves two areas, namely: analysis, and design. To evaluate the success of the two areas, implementation of an IS system is necessary. Although this last area is not the focus of the subject modules, it is implemented in the form of a prototype. From this premise, the teaching of SA&D draws on project-based learning. It therefore involves group work, and imitating the work environment through IS development. All study units are applied in this context, and this group project is assessed in a presentation-demonstration session at the end of each semester.
Technological sphere (A tool used to represent content knowledge or do demonstrations, and more. Especially digital technology require the educator to acquire knowledge of computer hardware and software).	With the rapid changes associated with digital technology, it is important for educators to keep abreast of new developments, adapt to changes, and adjust their knowledge on the matter. Although many tools are available, the lecturer needs to determine which ones in combination may be useful. In this study, the three focal points require the lecturer to compile a SMARTguide, produce videos and create a WhatsApp group, ensure that students have access to the technology, and in the case of the WhatsApp groups, manage its use.
Pedagogical-content intersection (This intersection presents discipline-specific concepts using pedagogical techniques. It includes knowledge of which concepts are easy or difficult to learn, how to scaffold information occurs, and how to stimulate active learning).	In dealing with SA&D content, the lecturer should consider the best ways to represent the material. In IS, the case study is a powerful tool in explaining the application of constructs. This may be preceded by the explanation of constructs to be utilised, focusing on the construct(s) relevant to each situation.
Technological-content intersection (Technology influence the way we present content).	In SA&D the initial utilisation of MIMAs allowed as little as 16 participants in a group, demanding the creation of a number of groups. Currently groups of up to 250 participants may be created. Therefore technically only one group could be used – which brings new issues to the fore, such as the possibility of not allowing each learner's voice to be heard in such a large group. For this reason lecturers should know their subject matter as well as how it may be changed when applying technology to it. When teaching technological subject matter, such as SA&D, this reciprocal relation becomes more important – learners apply what they see in class. When establishing communication channels between people and software, user interfaces are designed and built; a tool such as Microsoft Visual Studio makes C#, a programming language facilitating the creation of a graphical interface, available to learners to play with visual programming constructs which allow them to experiment with outcomes that may or may not adhere to HCI principles. The HCI principles displayed by the SMARTguides may influence the leaners to apply the same principles, whether good or bad, to the interfaces they create for their project systems.
Technological-pedagogical intersection (Technology supports teaching and learning).	The technological support of teaching, as in other subjects, is important in SA&D. It allows effective dissemination of feedback and assessment – in a transparent way. Without the use of technology, teaching, assessment, and feedback could only happen in class. With the use of technology, teaching may be preceded by a guidance provided by an interactive electronic study guide such as a SMARTguide, students may watch videos on challenging concepts in their own time to clarify points not clear to them, supported by a group that may be accessed 24/7 for the clarification of specific questions.

TPACK knowledge (assigned meaning by Mishra and Koehler (2006))	Contextual example from the study
Technological pedagogical content intersection (Educator brings together knowledge of the subject, how to teach and learn the subject matter, and the technology relevant in the transfer of knowledge).	In the context of SA&D, cognisance needs to be taken of the nature of the subject, how to best teach the subject matter using technology. This process may lead to the conclusion that technology implementations are not developed well enough to allow its utilisation in a specific aspect of the course, in other cases the approach of a particular application may not advance the purpose of an aspect which another application may address. Guidelines may direct this effort to ensure that a technology tool, not designed to support teaching and learning particular content, may be utilised effectively.

With TPACK placed in the context of this study, it is now mapped to the three focal points.

4.4.3 Mapping TPACK to the three focal points

With TPACK addressing the integration of technology, content, and pedagogy, as discussed in Section 4.4.1, is used in this study to guide the identification of guidelines of value to the research as shown in Table 4.7. It is important to use the two lenses of SA&D content, and the pedagogical principles (Table 4.5) applicable to this study when analysing technology use. The general nature of the three focal points of instructional design, formative guidance and summative assessment in relation to TPACK is the focus of the table, which may have positive (good) or negative (bad) implications.

Table 4.7: TPACK applied to this study

Knowledge	SMARTguide	Videos	WhatsApp
Content	Although a SMARTguide has little content, its focus is content and guiding students' knowledge acquisition and understanding. It allows direct access to small pockets of information, directed by tabs. This allows for a non-sequential approach.	Although videos do convey content knowledge, its sequential nature does not allow quick and easy access to content. In this study's context, concept videos address contents regarded as challenging. The inclusion of a breakdown of the video may assist viewers to access particular content directly.	A large part of WhatsApp conversations do not include content, although it may contain specific parts of content – depending on the questions asked. It may direct students to content to be obtained in the textbook, a video, or a proposed solution. In many cases it is used to verify answers.
Pedagogical	A SMARTguide directs learning regarding the pedagogical SDL and PBL principles underlying the teaching and learning of the subject modules.	The nature of videos allows a pedagogical focus; conveying a train of thought – where to start when solving a specific problem, what should be done first, what happens next, and how is a solution verified?	A WhatsApp group would facilitate learning according to pedagogical principles; it is an ideal environment to facilitate learning how to solve a problem with the help of peers. When individuals do not reach an answer, it is fairly easy for peers to help them to apply their mind in such a way to obtain an answer.

Knowledge	SMARTguide	Videos	WhatsApp
Technological	A SMARTguide requires the lecturer to compile the guide, load it onto the LMS, and ensure that students are able to download it in a format that are accessible to them.	A video requires the lecturer to plan, design and produce videos that explain challenging concepts to students regarding the subject matter, load it onto the LMS, and ensure that students are able to download it in a format and size that are accessible to them.	The usefulness of a WhatsApp group requires the lecturer to gather contact information from students, enter it onto a mobile device, and then form, introduce, and manage the group. Administrative functions may require verifying new member requests, as well as add new members to the group. It may also be required to remove members not adhering to the ground rules. In the case of a group, its profile may be utilised well in conveying its nature and ground rules.
Pedagogical-content	A SMARTguide requires users to prepare themselves to ensure they learn concepts that are necessary to understand the subject material. Such preparation may include various actions (class attendance, completion of assignments, completing a project, watching videos).	The purposeful inclusion of pauses may assist students in applying their knowledge before viewing an answer immediately following a question. Reflective pauses may also assist the internalisation of knowledge.	The use of a WhatsApp group allow users to be guided (by a lecturer or a SMARTguide), follow up the guidance with actions (do an assignment, work on a project, watch a video), and then clarify prevailing questions.
Technological-content	Although the size of a SMARTguide may be a point of contention, the constraint of printed pages is not important in an electronic context. The electronic format also allows a SMARTguide to allow access to small portions of information to direct learning. Since it is accessed by students in their own time, it is a valuable tool in fostering self-directing, with a self-assessment component.	Although the production of videos may be through a variety of tools, videos are all viewed in similar fashion. The user may stop and start a video at any time and access a particular point with ease. It is preferred that a video addresses only one concept and that its length is short.	A WhatsApp group is used chronologically, which means that posted material *disappears* with the passing of time. During busy times, much material is relayed, and users may miss a particular message. Since the intended use of WhatsApp is for social purposes, the changed educational focus may pose challenges.
Technological-pedagogical	The technology of SMARTguides allows users to carry a virtual teacher with them on their laptops, tablets and phones. The fact that information is presented in small sections, allows easy access to weekly guidance to progress throughout an academic semester.	Videos may be an easy way to obtain needed knowledge regarding a (challenging) concept. Unfortunately a video cannot replace the value of answering similar, but more in-depth questions oneself. The use of additional knowledge acquiring material may therefore be of value to amend the use of videos.	A WhatsApp group created to support preparation for assessment, is valuable when students are using it to gain an understanding as to the best way to solve problems, and not as a shortcut way to get the answers for an assessment.

Knowledge	SMARTguide	Videos	WhatsApp
Technological pedagogical content	SMARTguides have very little content, and is similar to a written guide presented in PDF, but it does allow guidance to be broken down and accessed via tabs. Its use therefore allows the lecturer to help students focus on what is necessary to learn and apply at a particular point in time. This is of value in subject modules with much material, which may overwhelm students.	The focus of videos is on contents, but when classes are inverted, it supports this pedagogical approach. The fact that it is making use of technology may appeal to students who are used to consult YouTube videos.	Most students are making use of a MIMA, such as WhatsApp, as a way of communication. The formation of a group for the purpose of learning, allows the exchange of actual content, but it also allows the lecturer to continuously guide students with regard to the underlying pedagogy followed. The use of such technology gives the student instant access to the lecturer, as well as peers. The exchange of information extends beyond that of subject matter and guidance to solve logistical issues, or enquire about anything concerning the subject modules.

The distinction between TPACK spheres and intersections are complex, since the intersections combine two (or three) spheres without integrating them. The value of TPACK lies in its use as a tool of reflection regarding non-HCI guidelines that may amend HCI principles and guide the use of technology in a particular educational context. An important assumption to make, is that, in the SA&D educational context, the use of technology tools may differ from its intended use. This status may be achieved by manipulating the technology until it suits the intended use. When comparing SA&D to other important IT course subjects such as programming, where feedback is obtained from the compiler, and accounting, where the books must balance, it is evident that the latter two subjects self-correct the learner. In addition, the subject of business management requires only knowledge acquisition. The subjects of mathematics and communication though, have some resemblance to SA&D: principles and techniques should be applied in particular scenarios and in a particular way, with no self-correction support.

4.5 INITIAL GUIDELIINES

At the beginning of this chapter, the aim was set out to be the compilation of initial guidelines for the use of technology, by incorporating the three focal points of this study. The methodological processes (M_R) involved obtaining HCI foci from extant literature, and then the mapping of the derived HCI foci to TPACK. The inclusion of TPACK enriched the eight derived HCI foci and resulted in highlighting existing gaps. With the derived HCI foci mainly being technology focused, seven of the eight HCI foci was mapped to one of the seven TPACK categories, namely the technology sphere. Only one exception was found: the seventh HCI focus "*guide users by using physical and logical constraints*" which was mapped to the technology-content intersection. Upon reflection, this finding is not surprising, since per definition, HCI principles reflect technology independent of its context and use, and therefore will not accommodate content and pedagogy per se.

The value of the TPACK framework was anticipated to rather direct the compilation of guidelines that are not closely linked to technology, with the intention to amend the HCI foci to enhance the use of technology in the teaching and learning of SA&D. It was expected that the HCI foci will be enriched by guidelines, which will focus on the content and pedagogy spheres, and the pedagogy-content, technology-pedagogy, and technology-pedagogy-content intersections of TPACK.

Therefore, from this literature review, initial guidelines, as listed in Table 4.8, are extracted from extant research on HCI principles, as well as the TPACK framework.

Table 4.8: The initial guidelines, as derived from literature, and viewed in the context of the three focal points

Knowledge	Initial guideline	
Content	Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge.	
Pedagogy	The identification of teaching (and learning) approaches is paramount in support of the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.	
Technology	The preparation of a technology tool requires technological know-how on the part of the lecturer. Its accessibility is of importance. Directions regarding its download, and assistance may support the accessibility of downloads. The HCI foci listed are applicable to the technology sphere.	
	HCI focus	Initial guideline
	Consistency and familiarity facilitate learning (1).	The selection of technology tools should favour familiarity. In combination with simplicity and consistency regarding look & feel, movement, uses, speed of operation, and status indication within a technology tool, the user is allowed to become familiar with it in a short timeframe.
	Flexibility allows for effective use (3).	Flexibility regarding access to learning material is important, and a technology tool should be accessible via a variety of platforms (mobile, laptop, desktop) and modes (online, offline; sequentially and direct). Some knowledge of the underlying technology is necessary to ensure flexibility of use.
	Prevent mistakes, or allow for its clear identification (4).	The use of technology tools should be directed with clear information.
	Allow for recovery from mistakes by returning to a previous state (5).	It should be quick and easy to recover from mistakes occurring with regard to the use of a focal point. Mistakes include the corruption of either the application, or a file (in the case of a video), and sending a message to the wrong group, or with the wrong intention.

Knowledge	Initial guideline	
	Capabilities performed according to user intentions (6).	A technology tool designed or selected to guide teaching and learning should allow a user to use it to the user’s intentions. In addition, when more than one technology tool is made available, a user should be able to use the ones fit for a task.
	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7).	A task a user needs to perform, should involve a dialogue thread. The improvement of computer interfaces for use by humans should be based on measuring human perception, where humans perceive their environment through their senses (see, hear, touch, smell, taste).
	Timely communication of task status (8).	Sensitivity towards status feedback regarding a technology tool should be encouraged.
Pedagogy-content	Content should be taught in a way which conveys the message of the material learned. Typically, a particular technology tool would support only a part of the overall approach. The HCI foci listed are applicable to the pedagogy-content intersection.	
	HCI focus	Initial guideline
	Guide users by using physical and logical constraints (2).	The use of computer power and availability to guide user progression in using a technology tool.
Technology-content	Although technology typically does not constrain the transfer of large amounts of material, it should facilitate the presentation of small portions of information to direct learning when needed.	
Technology-pedagogy	Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.	
Technology-pedagogy-content	In support of a lecturer, technology should be a channel for content presented in a way through which students will best internalise concepts.	

These guidelines will be tested in the subsequent chapter, through interviews with students who made use of the technology included in the three focal points of this study.

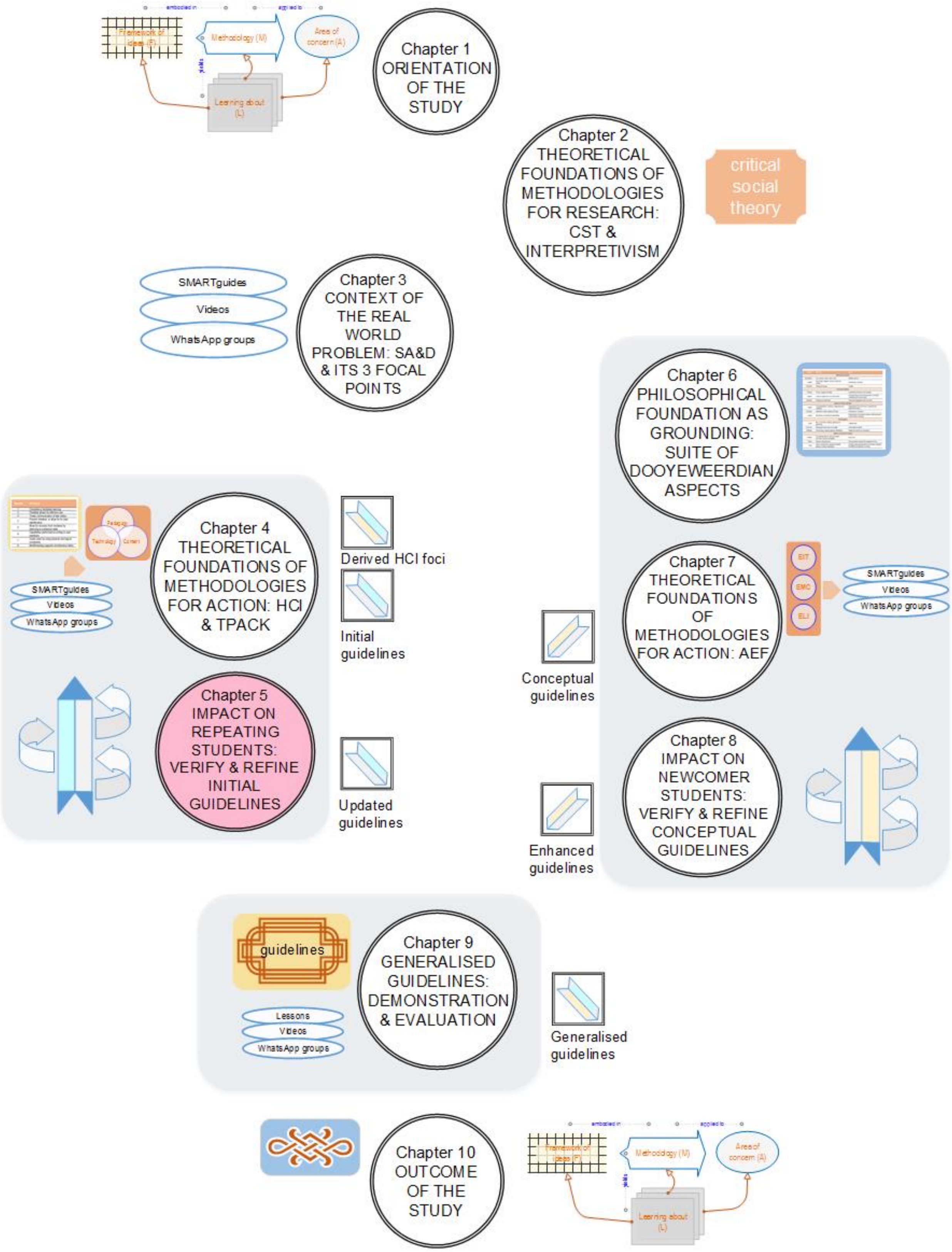
4.6 SUMMARY

The objective of this chapter was to gain an understanding of the use of technology in an educational setting; the focus being on principles guiding HCI, and this chapter addressed the second theoretical objective (T02), namely to enquire the integration of technology into teaching and learning to enhance academic success.

Firstly HCI principles from literature were considered. Through a process of consolidation, eight HCI foci were identified to be used in this study. The derived HCI foci was then mapped to the three focal points of this study. The framework for TPACK interaction (Mishra & Koehler, 2006), an education-specific framework with three areas, namely the technology sphere, the content sphere, and the pedagogy sphere, designed to be used in an educational setting, was discussed next. The purpose of its inclusion is an attempt to address the problems associated with the use of technology in education. The three spheres and four intersections of TPACK was then mapped to the three focal points of this study. A list of initial guidelines applicable to the three focal points of this study was derived from this literature review. It addressed the second reflective objective (R02).

In subsequent chapters the suggested integration is tested in the context of IS, and specifically using technology to teach a technological subject, namely SA&D. The purpose is to scrutinise the guidelines prevalent to the user interface. The subsequent chapter will discuss the implementation of an AR cycle. It will utilise the HCI principles, as well as the TPACK framework to evaluate the integration of technology into teaching and learning of a repeating group of students.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



5 IMPACT ON THE REPEATING STUDENTS: VERIFY & REFINE INITIAL GUIDELINES

5.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education, based on human computer interaction principles, from a Dooyeweerdian perspective.

In order to achieve the primary objective, this chapter addresses the first empirical objective (E01), namely to apply action research as five-step method to guide the verification and refinement of the initial guidelines obtained in the previous chapter – with the overarching purpose to emancipate students to enable them to reach their full potential. Three focal points, including instructional design, formative guidance, and summative assessment, are implemented in this action research cycle. This evaluation is guided by the derived human computer interaction foci and the framework for technological pedagogical content knowledge. The three technological instruments of instructional design, formative guidance, and summative assessment, form part of this cycle. The initial guidelines are verified and refined to obtain updated guidelines, and teaching and learning are improved.

In the subsequent sections, the focus of this chapter is firstly on the elements that are relevant to the study, and specifically to this chapter (§5.2). The action research cycle (§5.3) with its five steps of diagnosis (§5.4), planning for action (§5.5), taking action (§5.6), evaluation (§5.7), and learning specified (§5.8), is then presented in the context of repeating (R) students. It incorporates technology into the subject modules, and the focus is on students who are repeating the module, and their experience. The final section concludes the chapter with a summary (§5.9). The deliverable of this chapter is updated human computer interaction-technological pedagogical and content knowledge guidelines.

5.2 ELEMENTS RELEVANT TO THIS STUDY

As explained throughout this study, the refined Checkland and Holwell (1998b:23) model, is directing the research plan for this study as depicted in Figure 5.1. The focus of this chapter is on a real-world problem (P), which is solved through the application of the Action Research (AR) method (M_R).

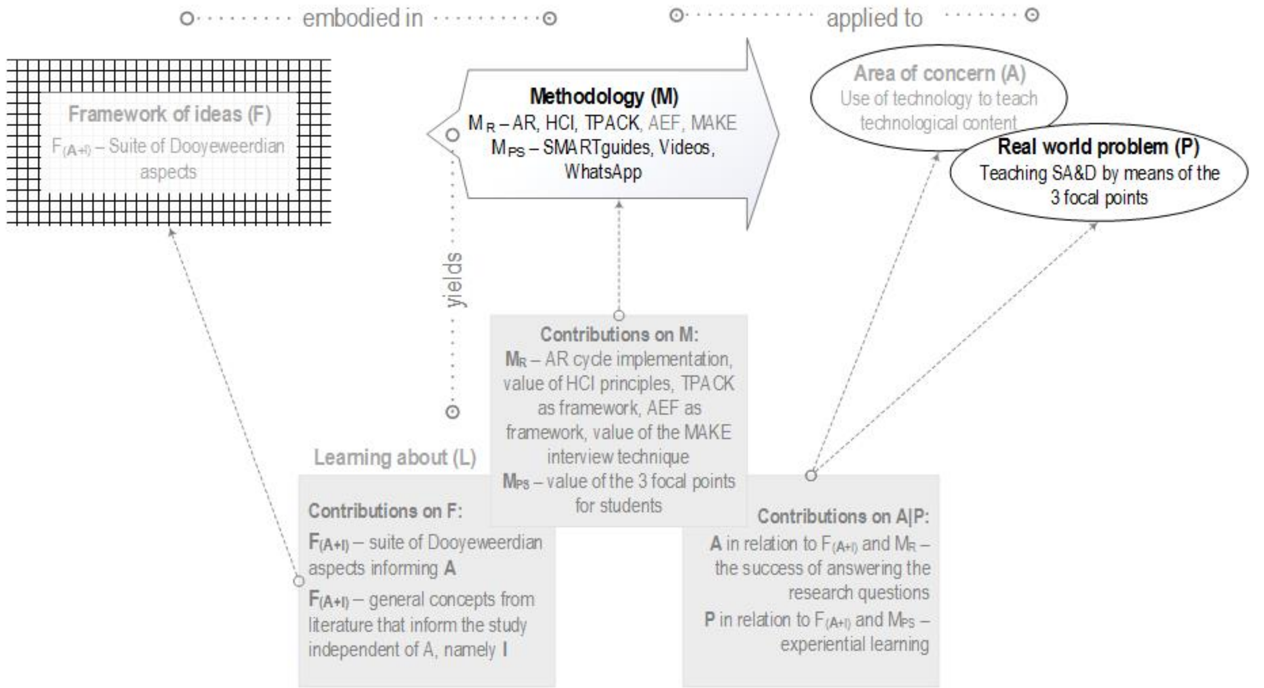


Figure 5.1: The elements relevant to this chapter

The problem presents itself in the form of the subject modules of systems analysis and design (SA&D) and how it is taught to **repeating** information technology (IT) students, with a specific focus on the three cases of technological instruments of SMARTguides to guide instructional design, Videos for formative guidance, and WhatsApp groups guiding summative assessment (MPS). Interviews are guided by human computer interaction (HCI) principles and the framework for technological pedagogical and content knowledge interaction (M_R) obtained from literature.

5.3 AR CYCLE R – BACKGROUND

In addition to the splitting of the class, the three focal points were fully developed at this point to support this new group of students.

In Chapter 4 the derived HCI foci were extracted from literature, and TPACK was investigated to support the technology implementation of this AR cycle.

In 2014 the first semester SA&D subject module offering was challenged with a class size that exceeded the seat allocation of the largest practical venue on the VC. The splitting of the class was discussed with students, but not implemented, because it was felt that the classes would not be the same for the two groups. With the class work conducted during practical sessions mostly in project groups, and the overflow being a small margin, it was decided to amend the seating for the venue as a solution to the problem. With the VC on a growing trend, and the IT course growing along with the campus, it was anticipated that the amended seating would not be a long term solution. Since 2015 the class was split into a group of students as new enrolments to the first SA&D subject module, and a second group of students repeating the module.

The research question for this iteration can therefore be stated as:

> *How can the lecturer utilise the three focal points, each with its particular niche in SA&D, to create a limber environment that will ensure that especially the* ***repeating*** *students reach their potential?*

Subsequently the five-step interactive AR process is used as research method in this chapter (Susman & Evered, 1978:588): the problem is diagnosed; a plan is compiled for action; action is taken; the action is evaluated; and learning is specified.

5.4 AR CYCLE R – DIAGNOSIS

This intervention with SA&D repeating students intend to emancipate students through the implementation of the three focal points into instructional design, as discussed in Chapter 2, Section 2.5.1.4. At the point of splitting the class, a secondary concern was whether the focus of newcomer students may hamper the progress of repeating students in the class?

Churchman (1968:29) guides the step of diagnosis with his suggestion of five considerations of a system: purpose, environment, resources, components, and management.

In this section the instructional design of the SA&D module for repeaters is viewed as a "*system*" in the context of the systems approach. With this section building on the original context of the study, Table 5.1 includes the contextual information from Chapter 3 as well. In the table each characteristic is described, that is followed by a contextual reference, and then the information regarding this iteration is stated.

Table 5.1: Churchman's considerations in diagnosing the instructional design of the repeater class of SA&D

Systems characteristic	Diagnosing the instructional design of SA&D
Purpose	Purpose: the purpose of a system is described as the overall, measurable objective of the system. Churchman (1968:31) argues that the real objective is not always clear, and typically the objective is that which will not be jeopardised by other decisions.
Context	The objective of the overall instructional design as a system is to guide each student to develop in terms of their SA&D skills and as life-long learner.
Class of repeating students	The original idea of the lecturer to support individual students, which should manifest in the encouragement of active participation, and therefore growth to an individual's full potential by making focused resources available to them, was amplified by splitting the class. The new situation created an opportunity for redesign, while in keeping with their basic knowledge of the material. In addition to this pre-knowledge of SA&D, which was anticipated to support the scaffolding of new knowledge, the smaller group enabled a more focused approach, allowing closer interaction between the lecturer and the group. From a critical perspective, it is important to recognize that a repeating student has, per definition, been negatively affected and is therefore in need of additional attention. Keeping in mind that this new group of students failed the SA&D subject module during a preceding year, it was deemed important to make an effort to re-focus the learning of this group. The fact that the repeating learners did not pass the module may be due to any of a number of reasons such as financial difficulties, personal problems, low motivation, or other obstacles. The focus was not on the pass rate of the group as such, but rather a broader perspective, as promoted by Bunce and Bennett (2019:2), as well as Nixon et al. (2018:939). The purpose of the class design was to create a positive and rich learning environment. Taking the pre-knowledge of this group into consideration, it was decided that this group should write the semester assessments, and complete a project which commences very early in the semester. Also, it was decided that the group of repeating students would not be required to write the baseline tests, and also not do the weekly assignments. To allow the repeating students to build participation marks, new instruments had to be designed in accordance with their needs. Discussions with the students and colleagues indicated that a game-based approach may best assist learning. By design it inverted the class.
Environment	Environment: Churchman (1968:36) posits that the environment of a system cannot be influenced by the system, but it influences the objectives of the system.
Context	The environmental aspects of this study are: • Poor socio-economic background. • Limitations in practical laboratories on campus. • Specific functionality of the LMS outside campus boundaries. • Limited contact time: only two double contact sessions. • Limited study hours per module in the programme.
Class of repeating students	The insufficient seating in the practical venue was solved by implementing two practical groups. Venues used for theory classes were sufficient to accommodate both groups, which resulted in a class split only for the weekly double contact session reserved for the practical class work session, although practical venues are not suited for the game-based focus of the intended instruments. Also, the intention was to use the project groups in the games planned, to create an atmosphere of competition.

Systems characteristic	Diagnosing the instructional design of SA&D
Resources	Resources: opposed to the environment, resources can be manipulated in the system and utilised to reach the objective of the system (Churchman, 1968:37).
Context	In support of the subject plan preceding the AR cycles, shown in Chapter 3, Figure 3.2, the learning resources which were relied upon to support students in their endeavour to internalise concepts, with the motivation for the inclusion of each, can be referred in Chapter 3, Table 3.3. The instruments which are contributing to the participation mark of the students – for both semesters – are shown in Table 3.4.
Class of repeating students	Before the splitting of the class, the three focal points were at different stages of development. Therefore, since the splitting of the classes, the three focal points could be utilised as resources for both groups. All resources available to students before the splitting of the class, were still accessible, but the focus moved away from formal teaching and assessments, toward game playing for the purpose of earning marks. Class work, done by the newcomer group during the weekly practical double contact session, was discarded in favour of playing games. In addition to the games as instruments, contributing to the participation mark in replacement of the class tests, an assignment, called the “big assignment”, replaced the weekly assignments in contributing to the participation mark. In the design of the inverted class, it was decided to incorporate interactive activities with an underlying competitive nature. Already existing project groups were included in the design of instruments. Study units covered in the first semester of SA&D were grouped into three categories and were matched to three types of competitions (Chapter 5, Table 5.2). A third instrument contributing to the participation mark, draws on an activity included in the second semester module, where the project groups are required to do a weekly presentation of project implementations per study unit. Since the repeating learners are starting with their project work at the start of the semester, this instrument supports the weekly progress of the project work. It has the intention to develop the presentation skills of learners and hone their critical voice. The instruments that are contributing to the participation mark of the group of repeating students, is shown in Table 5.3. The allocations for the second semester stay as it is indicated in Table 3.4.
Components	Components: components are subsystems in support of reaching the overall objective of the system. Each subsystem also has the characteristics of a system as listed in this table (Churchman, 1968:39).
Context	With different strageties for dividing the systems into components possible, it was decided to combine teaching and learning – along with the study units as components – with the contextual focus on the students and the splitting of the original class into a class group of repeaters and a class group of newcomers. After dividing the SA&D class group into two main components, for repeaters and for newcomers, this refined component division is applied to the group.
Class of repeating students	The repeating class component utilises teaching and learning to enable the overarching objective of developing a positive and rich learning environment in which repeating and newcomer students are encouraged to actively participate and thereby developing their full potential. The weekly teaching of study units individually supports the management of the overall objective. In support, the three focal points collaborate with the study units to ensure the overarching objectives of the subject modules are achieved.
Management	Management: management is the coordination of the resources which are subject to the constraints of the environment – by means of the components – in order to achieve the stated objective (Churchman, 1968:44).

Systems characteristic	Diagnosing the instructional design of SA&D
Context	The initial intention regarding the subject modules was to teach the modules in a structured way. Resources were developed with the following outcomes in mind: the lecturer needed to familiarise herself with the subject material as taught in this particular context, before making any major adjustments to the classes, and continuous preparation of the material by students was required, to ensure that all the material may be learned well. Assumptions made by the lecturer, include: • The NWU Sakai-based LMS, eFundi, was used as much as possible to facilitate the teaching of the subject modules. • To motivate students to prepare for class, class tests should be written before a class is offered. • To ensure continuous learning, each study unit has an accompanying assignment. • To facilitate students' capability to apply learned concepts in a practical setting, a weekly class work activity was completed. • Project groups had the intention to encourage students to work on their projects weekly. To support progress, three guiding instruments were utilised for the projects.
Class of repeating students	The formation of a new class group required the amendment of the subject plan to integrate newly developed resources which are subjected to restrictions in the environment. The three focal points of the SMARTguides, videos, and WhatsApp as MIMA is included in the design for the repeating students' class. Resources are used in support of the components implemented, in order to achieve the overall envisaged educational purpose. The updated subject plan is shown in Figure 5.3. For example, the WhatsApp group is formed during the first semester, while it supports the full second semester. Assessments and their weight contribution are shown with stars. With the focus of the group of repeating students being on playing games, the activities earning marks undertaken in a preceding year, such as class tests, assignments, and class work, became part of the resources to be utilised in preparing for the games. Also, the formal class became part of the toolbox of instruments from which to choose in preparing for the games. This purposed that each student was encouraged to direct his/her own learning towards becoming more self-directed learners. Partly this teaching and learning strategy has the purpose to remove some of the substantial pressure created by the weekly class tests and assignments.

Study units covered in the first semester of SA&D were grouped into three categories and were matched to three types of competitions, is shown in Table 5.2.

Table 5.2: Format and assessment of quiz, happy hour, and expert witness games mapped to study units covered in SA&D

Activity	Actions	Assessment	Study unit category (Bentley & Whitten, 2007)
Quiz	In preparation, each group compile a list of questions with accompanying answers due the day before class.	Half the potential marks are allocated according to three criteria; enough questions, complete answer per question – with reference to the appropriate page number in the prescribed text book, and involvement of group members.	Theoretical underpinnings with little potential to apply practically: the value of SA&D (SU1), the components of IS (SU2), developing ISs (SU3), and systems analysis (SU5).

Activity	Actions	Assessment	Study unit category (Bentley & Whitten, 2007)
	Each group is allowed to ask a question to the next group. Succession of questions occurs in a round robin fashion. A particular question is directed at a particular group; they have limited time to answer and earn points when supplying the correct answer. If not, the next group in line gets an opportunity; with less time available and the potential to earn less marks. Timeframes are adjusted as the hour progresses.	According to each group's performance in the quiz, and their attendance, they are allocated the outstanding half of the marks.	
	At the end of an hour, the points are added up and a winning group is announced.		
Happy hour	A succession of questions, slightly more involved than the typical quiz-question, is prepared beforehand by each group of students. An answer to each question is also supplied.	According to each group's performance and individual member attendance, marks are allocated for each happy hour.	Equal reliance on theory and its implementation: the project management cycle and the implementation of its tasks (SU4), and the techniques pertaining to data gathering for the discovery of requirements (SU6).
	In class each group appoints an arbiter, a scribe and a runner with the rest of the group (3 to four members) responsible to find answers to questions posed.		
	The format is as such; a question is asked and groups investigate the answer, when the answer is found, the scribe writes it on a piece of paper and the runner takes it to the group of arbiters sitting at a table in front of the class. As soon as the first answer is delivered, the arbiters count to 30. The groups still searching for an answer can deliver their answers during this timeframe. When the time is up, the answer is displayed and the arbiters decide the points allocated to each group. As the hour progresses the count to 30 are lessened to 15, and then to 10.		
	At the end of an hour, the points are added up and a winning group is announced.		
Expert witness	A scenario is prepared with between one and three questions that is based on the scenario asked – by a student assistant in collaboration with the lecturer. A model answer to each question is also supplied.	According to each group's performance and individual member attendance, marks are allocated for each expert witness session.	Practical implementations with little theoretical knowledge required: the development of use-cases (SU7), data modelling and data analysis (SU8), process modelling (SU9), and feasibility analysis (SU10).
	The scenario-question combination requires each group to compile an implementation in a restricted timeframe. Upon completion each group is allowed to explain their answer to the other groups, and answer any questions. Finally a model answer is displayed.		
	By a show of hands a winning group is announced. After the class, the lecturer moderates each group's answer. This is followed by feedback and a resultant mark.		

The instruments that are contributing to the participation mark of the group of repeating students, is shown in Table 5.3. The allocations for the second semester stay as it was indicated in Chapter 3, Table 3.4.

Table 5.3: Instruments contributing to the participation mark

Semester 1 Group: repeating students	Number	Weight
Quiz Happy hour Expert witness	4 2 4	10
Big assignment	1	10
Semester tests	2	50
Group project: 1. Weekly presentation 2. Consultation 3. Final presentation & demonstration	 1-3 1 1	30

The original subject plan which was shown in Chapter 3, Figure 3.2 is repeated in Figure 5.2.

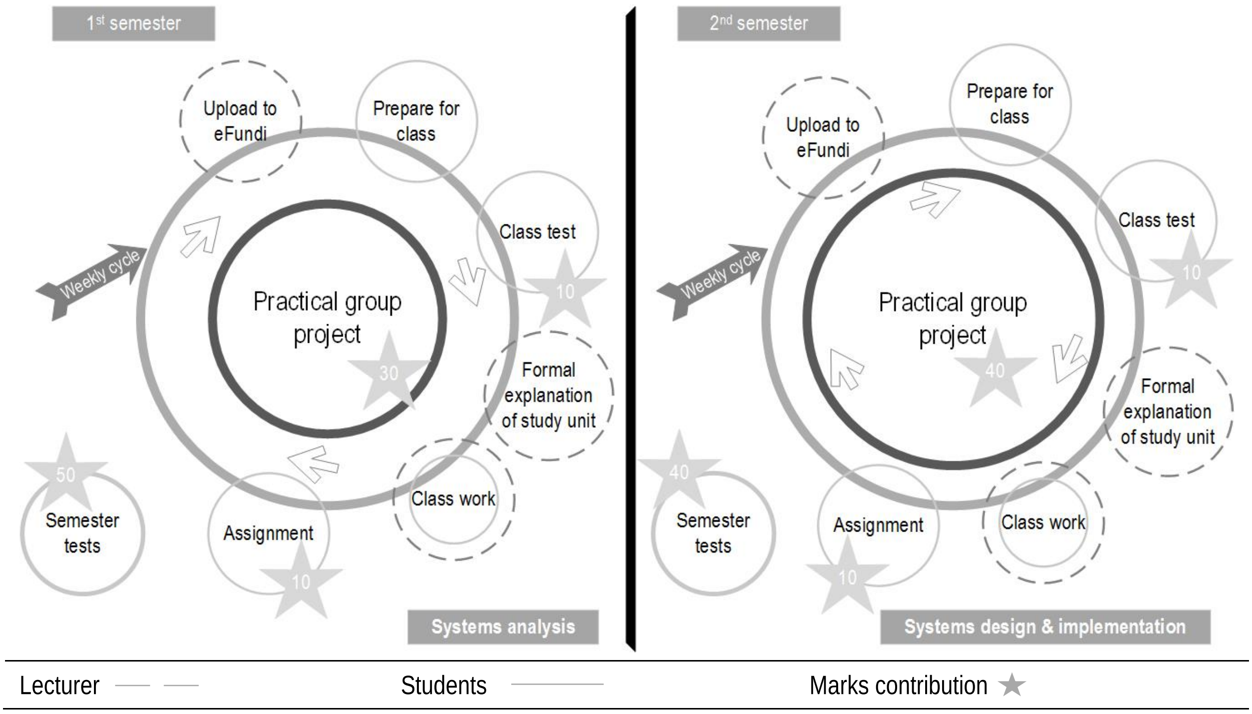


Figure 5.2: Original subject plan

The adjusted subject plan is shown in Figure 5.3. It is an amendment to the original subject plan.

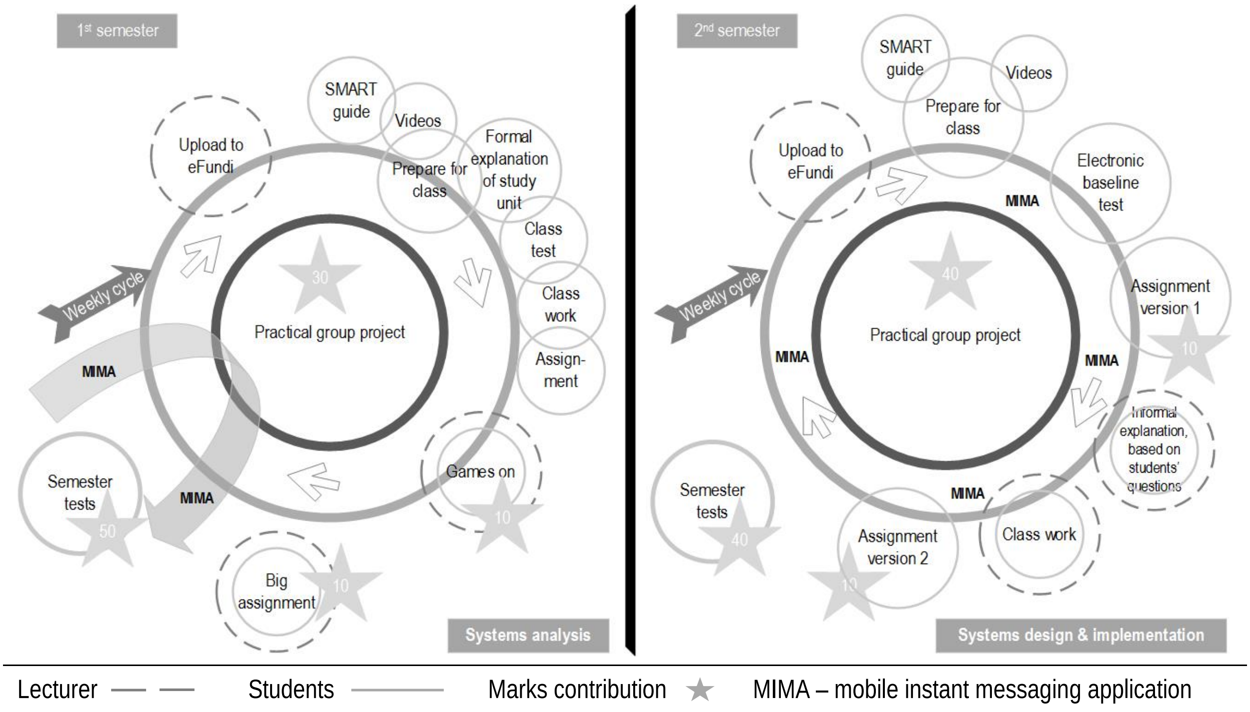


Figure 5.3: Adjusted subject plan – repeating students

Both semesters are shown in the revised subject plan for repeating students, which directs the management of the instructional design of SA&D, and all activities. The resources of this system are indicated with circles. Each weekly cycle starts with the necessary work being uploaded onto eFundi – part of the instructional design environment, and progresses clockwise. Circles with broken lines show eFundi uploads or printouts by the lecturer. Solid circles show activities done by students, either individually or in groups. The components as focal points form part of the weekly cycle. As example, the WhatsApp group as mobile instant messaging application (MIMA) implementation, is formed during the first semester, while it supports the full second semester. Assessments and the weight contribution of each is shown with stars.

5.4.1 Conclusion of the diagnosis of this AR cycle

The problem that is addressed in this AR cycle, is that students repeating SA&D, did not have sufficient educationally sound technology support (refer Chapter 2, Figure 2.8) to allow them to develop towards their full potential.

5.5 AR CYCLE R – PLANNING FOR ACTION

The theoretical framework guides the uncovering of planned actions, which suggests a desired future state for the institution, as well as the approach to change and the changes necessary to achieve the targeted state (Baskerville & Pries-Heje, 1999:15).

The initial guidelines with TPACK and the incorporated eight derived HCI foci has been compiled in Chapter 4, and is shown here in Table 5.4. Again, numbers indicated correlate with the importance allocated to each by Hinze-Hoare. The initial guidelines will guide this AR intervention cycle.

Table 5.4: The initial guidelines, as derived from literature, and viewed in the context of the three focal points

<table>
<tr><th>Knowledge</th><th colspan="2">Initial guideline</th></tr>
<tr><td>Content</td><td colspan="2">Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge.</td></tr>
<tr><td>Pedagogy</td><td colspan="2">The identification of teaching (and learning) approaches is paramount in support of the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one’s solution.</td></tr>
<tr><td rowspan="7">Technology</td><td colspan="2">The preparation of a technology tool requires technological know-how on the part of the lecturer. Its accessibility is of importance. Directions regarding its download, and assistance may support the accessibility of downloads. The HCI foci listed are applicable to the technology sphere.</td></tr>
<tr><td>HCI focus</td><td>Initial guideline</td></tr>
<tr><td>Consistency and familiarity facilitate learning (1).</td><td>The selection of technology tools should favour familiarity. In combination with simplicity and consistency regarding look & feel, movement, uses, speed of operation, and status indication within a technology tool, to which the user is allowed to become familiar with in a short timeframe.</td></tr>
<tr><td>Flexibility allows for effective use (3).</td><td>Flexibility regarding access to learning material is important, and a technology tool should be accessible via a variety of platforms (mobile, laptop, desktop) and modes (online, offline; sequentially and direct). Some knowledge of the underlying technology is necessary to ensure flexibility of use.</td></tr>
<tr><td>Prevent mistakes, or allow for its clear identification (4).</td><td>The use of technology tools should be directed with clear information.</td></tr>
<tr><td>Allow for recovery from mistakes by returning to a previous state (5).</td><td>It should be quick and easy to recover from mistakes occurring with regard to the use of a technology tool. Mistakes include the corruption of either the application, or a file (in the case of a video), and sending a message to the wrong group, or with the wrong intention.</td></tr>
<tr><td>Capabilities performed according to user intentions (6).</td><td>A technology tool designed or selected to guide teaching and learning should allow a user to use it to the user’s intentions. In addition, when more than one technology tool is made available, a user should be able to use the ones fit for a task.</td></tr>
</table>

Knowledge	Initial guideline	
	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7).	A task a user needs to perform, should involve a dialogue thread. The improvement of computer interfaces for use by humans should be based on measuring human perception, where humans perceive their environment through their senses (see, hear, touch, smell, taste).
	Timely communication of task status (8).	Sensitivity towards status feedback regarding a technology tool should be encouraged.
Pedagogy-content	Content should be taught in a way which conveys the message of the material learned. Typically, a particular technology tool would support only a part of the overall approach. The HCI foci listed are applicable to the pedagogy-content intersection.	
	HCI focus	Initial guideline
	Guide users by using physical and logical constraints (2).	The use of computer power and availability to guide user progression in using a technology tool.
Technology-content	Although technology typically does not constrain the transfer of large parts of material, it should facilitate the presentation of small portions of information to direct learning when needed.	
Technology-pedagogy	Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.	
Technology-pedagogy-content	In support of a lecturer, technology should be a channel for content presented in a way through which students will best internalise concepts.	

As an intermediate step, Table 5.5 is introduced to map the component application that is underlying the action taking phase of AR.

Table 5.5: The planned intervention related to the initial guidelines

Knowledge	Initial guideline	Application in AR cycle
Content	Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge.	The material presented in the SMARTguide are logically grouped and accessed via tabs. Provision is made for repeating students. A video addresses only one concept. WhatsApp conversations focus on questions asked, and answers supplied. In general, resources are designed to support individual study units. The support provided by the three focal points which are embedded in technology, will provide guidance regarding breaking down the material presented without technology, such as concepts addressed in the prescribed textbook.

Knowledge	Initial guideline	Application in AR cycle
Pedagogy	The identification of teaching (and learning) approaches is paramount in support of the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.	The components and available resources form part of a cycle-per-study unit. New material is taught in the context of solving real-world problems presented as scenarios. Students are supported while solving the problems, and also provided with feedback on student generated solutions. By splitting the class, this guideline is verified in terms of providing focused instruction to repeaters, while, at the same time, providing the traditional experience to the newcomer students.
Technology	The preparation of a technology tool requires technological know-how on the part of the lecturer. Its accessibility is of importance. Directions regarding its download, and assistance may support the accessibility of downloads. The HCI foci listed are applicable to the technology sphere.	Creating a SMARTguide, producing a video, and forming and managing a WhatsApp group requires a lecturer to have basic technological knowledge. The technological knowledge should include know-how regarding how to make the applications accessible to students, and support them when they get stuck when downloading it, or experience problems when using it. The splitting of the class allows the lecturer to focus on the unique problems each group experience, when they experience it.
	Consistency and familiarity facilitate learning (HCI1): The selection of technology tools should favour familiarity. In combination with simplicity and consistency regarding look & feel, movement, uses, speed of operation, and status indication within a technology tool, the user is allowed to become familiar with it in a short timeframe.	IT students are familiar with technology, NWU students know printed study guides, students in general are familiar with YouTube videos, and students were asked to indicate the social media tool they prefer. WhatsApp evolved to be the tool used since most students are already using it.
	Flexibility allows for effective use (3): Flexibility regarding access to learning material is important, and a technology tool should be accessible via a variety of platforms (mobile, laptop, desktop) and modes (online, offline; sequentially and direct). Some knowledge of the underlying technology is necessary to ensure flexibility of use.	SMARTguides and videos are accessible on the full range of devices students may own, while WhatsApp is designed to be a mobile application. For the convenience of having it threaded on a PC, WhatsApp web and other applications allow access to it on a PC or laptop. Knowledge of WhatsApp's features allow a user to adjust it to personal preferences.
	Prevent mistakes, or allow for its clear identification (4): The use of technology tools should be directed with clear information.	Tabs and arrows are clearly indicated for the purpose of navigation in the case of the SMARTguide tabs, videos are easily manipulated using commonly used start, stop, forward and backward icons, and update notifications are clearly stated with the use of WhatsApp. The simplicity of SMARTguides and videos, allows for effective use. Additional guidance regarding the use of WhatsApp for academic purposes were necessary.
	Allow for recovery from mistakes by returning to a previous state (5): It should be quick and easy to recover from mistakes occurring with regard to the use of a technology tool. Mistakes include the corruption of either the application, or a file (in the case of a video), and sending a message to the wrong group, or with the wrong intention.	In the instances of the SMARTguide and WhatsApp, past versions did not include sufficient features to support recovery from mistakes, while some video playing software may still fall in this category. Improvements regarding this focus, should improve the interaction of the focal points.

Knowledge	Initial guideline	Application in AR cycle
	Capabilities performed according to user intentions (6): A technology tool designed or selected to guide teaching and learning should allow a user to use it to the user's intentions. In addition, when more than one technology tool is made available, a user should be able to use the ones fit for a task.	A student may decide how a SMARTguide or video is to be used, for instance sequentially, or according to the user's need at a particular point in time. In the case of WhatsApp, a student may decide on participation involvement.
	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7): A task a user needs to perform, should involve a dialogue thread. The improvement of computer interfaces for use by humans should be based on measuring human perception, where humans perceive their environment through their senses (see, hear, touch, smell, taste).	A student may have the three focal points, in addition to some resources (for example a textbook), accessible on the preferred device to be guided to watch a video, be watching it, accessing the textbook to search for answers, and ask unanswered questions on WhatsApp. The three focal points allow for the utilisation of multiple senses to support the perception of their environment. Students see visual material, hear sound, and use their touch sensor on a touch screen.
	Timely communication of task status (8): Sensitivity towards status feedback regarding a technology tool should be encouraged.	Applicability includes the self-assessment interactive components of the SMARTguide – to ensure that students are guided towards the correct answers, communication when watching a video, and, users' need to be aware of subtle status communication from WhatsApp, (for instance a change in colour regarding a delivered message being read), since the progressive use of the technology depends on it.
Pedagogy-content	Content should be taught in a way which conveys the message of the material learned. Typically, a particular technology tool would support only a part of the overall approach. The HCI foci listed are applicable to the pedagogy-content intersection.	The focal points support teaching in the following ways: the SMARTguide supports students in their preparation for class (watch a video, or take a self-assessment test), a video may include reflective pauses directed by the lecturer – to perform a small assignment before finishing a video, and WhatsApp allow a student to clarify any still existing issues regarding the topic of the video. Differences between the two classes after the split, manifest on the WhatsApp groups, where questions are asked, and answers are supplied.
	Guide users by using physical and logical constraints (2). The use of computer power and availability to guide user progression in using a technology tool.	The self-assessment tests included in the SMARTguides provide an opportunity to use a computer to logically guide students towards an answer. Multithreading, facilitates logical guidance via the three focal points in combination with one another, as well as other tools. Physical guidance manifests when students can learn anywhere – because they have a device at hand.
Technology-content	Although technology typically does not constrain the transfer of large parts of material, it should facilitate the presentation of small portions of information to direct learning when needed.	In the case of this study, there is a strong link between technology-content, and content, since the components are technology tools. The focus is on small portions of subject matter to ensure easy access. By presenting the material in small portions, repeating students can effectively select sections of the material which require more intense focus – according to their needs.

Knowledge	Initial guideline	Application in AR cycle
Technology-pedagogy	Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.	In the case of the three focal points, the SMARTguide represents a virtual teacher that guides students before and after the physical class, videos allow students to view explanations on challenging concepts before and after class, multiple times – if and when necessary, while WhatsApp allows questions to be asked whenever it occurs. The WhatsApp groups allow the lecturer to support the two groups of students, formed after the class split, according to their specific needs.
Technology-pedagogy-content	In support of a lecturer, technology should be a channel for content presented in a way through which students will best internalise concepts.	SMARTguide use allows the lecturer to help students focus on what is necessary to learn and apply at a particular point in time. Videos support inverted classes. A MIMA such as WhatsApp is an important way of communication for students that may easily be expanded to support the specific learning needs of each group after splitting the class.

One aim of this intervention is to verify and refine the guidelines extracted in Chapter 4. It supports a second aim, which is to emancipate students repeating SA&D to reach their full potential. An interview, using unstructured questions, is used for this purpose. The development of the directing questions for the planned interviews are guided by the initial guidelines.

5.6 AR CYCLE R – TAKING ACTION

The intention with the introduction of the three technological instruments was twofold: to expand the resources available to students in their preparation to become information system development specialists; and to establish the educational purpose of each technological instrument. In the event of the introduction of the technological instruments the educational themes of formative guidance, summative assessment, and instructional design presented themselves chronologically:

1. The introduction of short videos on challenging concepts formed the basis for the educational purpose of reversing classes, which supports self-directed learning.
2. The formation of WhatsApp groups facilitated the educational purpose of students using their already existent mobile devices to learn from peers and have the support of their lecturer when they prepare for assessments. A dedicated repeater group was formed to ensure that no comments regarding the different focus of the newcomer group would confuse this group of students.
3. Lastly, the development of interactive electronic study guides created the opportunity for the third educational purpose of adding a study guide to the mobile device in the hand of students.

Throughout this study, the technological instruments that represents the educational themes are discussed in the logical order (as opposed to chronological) of overall instructional design (represented by the SMARTguides), focussed formative guidance (represented by the videos), and concentrated guidance for summative assessment (represented by the WhatsApp groups).

Throughout the introduction of the technology tools, the fact that the interactive electronic study guides are the only technology tool designed for the purpose it is used for in this educational environment, is kept in mind: WhatsApp is not designed to be utilised as a teaching and learning tool – but rather for socialising, and the traditional use of videos is in a much broader context – although they do have some record as a teaching tool. It is accepted that, especially in the case of the WhatsApp groups, the evolution of a tool, the size of groups, and the composition of a particular group pose specific challenges. These limitations have been utilised to extract the initial guidelines, and it is anticipated that the guidelines posed as outcome of this study, will guide future implementations.

The intervention that is the subject of this AR cycle includes repeating students using the three focal points in their context, from 2015 to 2018 (Chapter 2, Figure 2.8).

In order to supply supporting information regarding the introduction of the three technological instruments, Table 5.6 displays information on a set of criteria, namely, its purpose, objective, material to support the instruments, lecturer support, how the focus changes between the first and second semesters, and the software technology used to develop the instrument. The aspects applicable to only the repeating students are shown in *italics*.

Table 5.6: The three focal points; SMARTguides, Videos, and WhatsApp groups listed, using a set of criteria

Topic	SMARTguides	Videos	WhatsApp groups
Objective	To guide students throughout each module by dividing the work into weekly topics with interactive material.	*To assist students in their preparation of challenging concepts for the interactive game-based sessions. Videos also support revision of challenging concepts.*	To support students in their preparation for assessments.

Topic	SMARTguides	Videos	WhatsApp groups
Action to create	Designing, developing, testing, implementing and support of interactive electronic study guides referred to as SMARTguides: • S - Student • M - Management • A - Assessment • R – Remediation • T – Tracking.	Identifying challenging concepts from each study unit, then the production of short videos on those concepts.	Gathering information from students on their preferences regarding MIMAs to be used on their mobile devices and then forming groups according to the needs of the students.
Resources in support	Supporting material: • All material referenced is stored as eFundi Resources. • Feedback on the practical project done by groups of students supports the guidance provided by the SMARTguide, as it prompts students to convert the theory studied, to its practical implementation. • Feedback from students regarding the SMARTguides uses the eFundi Wiki.	Supporting material: • Prescribed text book used for class preparation. • Slides grouped per specified outcome. • Slides used for teaching specified outcomes. • Preparation of specified material – additional reading. • Formal classes offered. • Feedback on class related actions is stored as eFundi Resources.	Supporting material: • *Game-based work used in and/or after class addresses different learning styles and is based on group work.* • *Reflective Big Assignment.* • Semester test preparation sessions are conducted. • Semester Tests are written and feedback are provided on eFundi Resources. • Examination preparation sessions are conducted to prepare for summative assessments.
Lecturer support	Academic Development and Support.	Student Assistants, Supplemental Instructors and Tutors.	Administrative staff, Invigilators and Student Assistants.
Supporting technology	SMARTguides are produced in MS PowerPoint, then converted to Articulate Storyline and finally stored in PDF-format.	In 2011 the VC acquired a technology tool, SmartPodium, which enables the production of videos. Videos are also produced using suitable software like Blueberry FlashBack Express, then stored as a Firefox HTML document to be uploaded on eFundi.	WhatsApp as MIMA is used to create a group or groups. Every member receives all messages sent by any other member. In addition to text, it allows for photographs, voice messages and video-clips to be distributed.
Access to components	A downloadable link is supplied on eFundi Resources. Instructions regarding access to supporting software are supplied.	Videos are uploaded onto eFundi Resources to be watched and/or downloaded. It is also embedded into the SMARTguides to allow access when SMARTguides are downloaded onto student devices.	The mobile phone is the primary device. Supporting applications along with an Internet connection allow access via tablets, laptops and PCs as well.
Change of focus from 1st to 2nd semester	Guidance supports normal instruction in the first semester and reverse instruction in the second semester.	No formal teaching of concepts to support reverse instruction; a class focuses on the specified outcomes related to the study unit covered, student questions asked, and questions formulated by the lecturer to encourage discussion of relevant work. Class Work is expanded to address group work related to specified outcomes – in support of the focus placed on the development of practical group projects.	Baseline class tests and its feedback are written on eFundi before class and therefore is taking up no class time. Fewer semester tests are written to allow more time for students to reminisce and work on their projects.

With the three focal points of this study standing central to the teaching & learning of SA&D, in addition to improving the experience of students, the success of the technological instruments regarding its use in the context of repeating students, is scrutinised. Table 5.5 is used to guide the success of the implementation of the three focal points. The literature regarding HCI principles and the framework for technological pedagogical and content knowledge interaction (TPACK), which was discussed in Chapter 4, apply.

5.7 AR CYCLE R – EVALUATION

The AR Cycle R intervention placed the focus on repeating students. This focus was supported by the implementation of the three focal points of the SMARTguide, the Videos, and the WhatsApp groups. Two parts were addressed, namely problem solving, where students were supported to enable them to reach their full potential, and research, where guidelines were refined through a process of evaluation which evidenced in revisiting deductions made from literature regarding the derived HCI foci, and TPACK, interview development, the data collection strategy, and the analysis of the collected data.

5.7.1 Data analysis strategy

Chapter 2 is referred to guide the data analysis strategy to be followed in addressing the empirical objective of this chapter. Figure 2.9, in Chapter 2, which shows the content analysis process adapted from Elo and Kyngäs (2008:110), is shown here once again. In Figure 5.4 the directed approach of content analysis followed here, is highlighted in grey.

As overarching principle, the Hermeneutic Circle with its double hermeneutic reporting is employed as mode of analysis of this study. Three effects are anticipated: (1) the gathering of data is assumed to be affected by any presuppositions the researcher may have, and the questions asked will determine the answers of participants; (2) when analysing the data, the data is affected, and vice versa, data also affects its analysis; and (3) the context of a particular interview needs to be considered when meaning is attached to words used in the data.

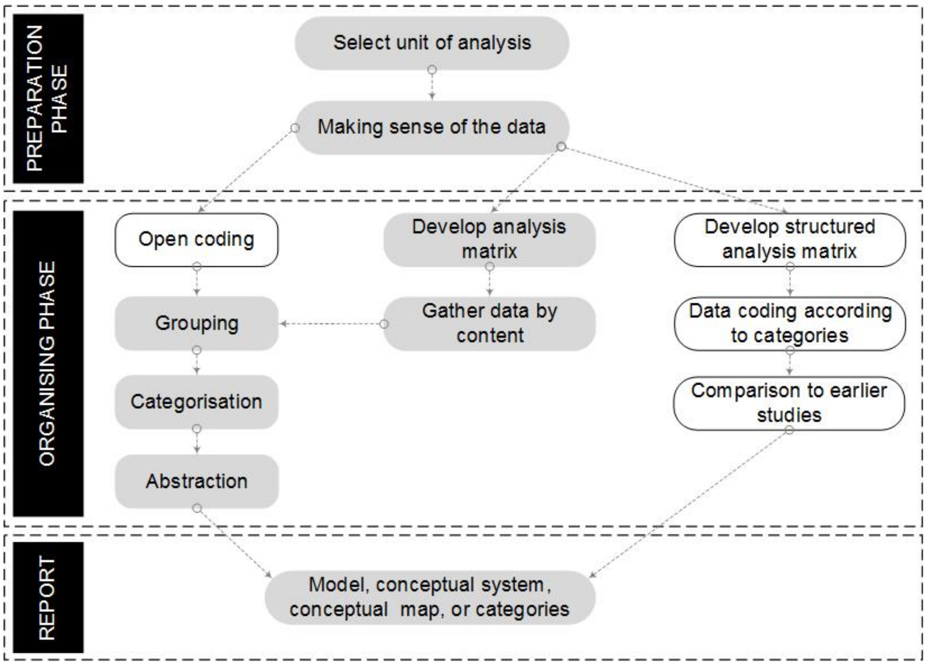


Figure 5.4: The content analysis process as adapted from Elo and Kyngäs (2008:110)

The directed content analysis approach shown in Figure 5.4 directs data analysis as follows:

- To select the unit of analysis is the first step in preparing the data. In the case of this study, the unit of analysis is an entire interview with a participant – which is recorded for reference purposes. By considering an interview with a specific participant as unit of analysis, the researcher could obtain an understanding wider than the specific.
- Make sense of the data and the whole concludes the preparation of the data. Asking questions regarding *who* (spoke), *where* (did it happen), *when* (did it occur), *what* (happened), and *why* (it happened) while listening to each recording several times will assist the researcher in becoming fully immersed in the data.
- The organisation of the qualitative data is started with a developed analysis matrix. This process started in Chapter 4 with the compilation of the HCI foci from literature. The interview questions are developed from the list of initial guidelines – to obtain updated HCI-TPACK guidelines.
- Data is gathered by content. It entails compiling codes while listening to each interview with the intention to describe all aspects of the interview. It often requires one to listen to an interview more than once. Codes are represented in table format.
- The organisation of the qualitative data is continued by grouping the data. Related codes which belong together to describe a phenomenon, are grouped to form

categories. Categories are used to describe a guideline direction. This may include describing the guidance of one of the focal points, or an expression of such guidance. At the same time, abstraction is applied to the data to form themes which convey meaning with regard to the research. A theme is used to describe a guideline or a recommendation for improvement. This step concludes the organisation of the data.

- Report on the improvements suggested, and extracted updated HCI-TPACK guidelines obtained. This is done in the "*Learning specified*" step of the AR cycle.

Trustworthiness is in essence not a step, but rather a mindfulness, and it is therefore reflected upon after completion of data analysis. Since ensuring trustworthiness is involved, a list of questions have been formulated to guide it in Table 5.7.

Table 5.7: List of questions designed to guide content analysis towards trustworthiness from Elo and Kyngäs (2008:110)

No.	Question to guide trustworthiness	Motivation	Result
1	Is the process of analysis as well as the ensuing results described in enough detail?	It should be clear to readers how the analysis was done. Its restrictions and strengths should be highlighted.	A dissected process and rigorous results.
2	Are the themes described by its categories, and categories by its codes?	Groupings should be anchored empirically, as well as conceptually.	Simplified data that is analysed and grouped to reliably reflect the subject under scrutiny.
3	Does the groupings cover the data well?	The researcher should be able to defend illations on sound and authentic collected data.	Detailed reporting that describes the analysis process, as well as the results. The inclusion of tables and appendixes may highlight links between the raw data and ensuing results.
4	Is the context, the participants, data collection, and analysis process described thoroughly?	Readers should be able to trace the process of inquiry followed.	Transferable research.
5	Are citations from the empirical data included without pointing to participants' identity?	Readers should be able to determine the origination of groupings.	Increased trustworthiness.
6	Was content validation done? A number of content validation techniques are available, including face validity, and the use of agreement coefficients. Options for seeking agreement may utilise a panel of experts, or dialogue among co-researchers.	Agreement on the grouping and labelling of data.	Valid coding and grouping of content.

5.7.2 Interview development

It was planned that, with the start of each interview, the ethical approach of study would be stated and the "*AUTHORITY FOR SA&D INTERVIEWS AR CYCLE R & N*" (Annexure

B) signed. The compilation of this document was guided by the TRREE ethics course: "*ETHICAL CLEARANCE*" (Annexure A).

A planned introductory discussion had the purpose to supply background information to inform each participant regarding the focus of the study. The HCI foci were explained, as well as the TPACK spheres and intersections.

In addition, it was planned that some biographical and background information would be gathered. These basic questions are listed in Table 5.8.

Table 5.8: List of initial questions designed to gather biographical and background information from participants

No.	Question	Motivation
1	What is your current age?	Age may allow comparisons between interview groups.
2	Why did you decide to study IT?	Determine whether participant had a clear motivation for his/her IT studies.
3	What is your current status?	Determine whether the participant is a student, studying a post-graduate degree, staying at home, or working?
4	What is the job you are currently doing?	If the participant is working – to determine whether the participant is involved in the IT industry.
5	What is your long term plan regarding your career?	Determine whether the participant has a clear vision for his/her future career in IT.
6	What is your preference regarding the class being split?	Determine whether the participant would have preferred to re-do the class designed for newcomer students, or whether the repeating group was a good design.
7	How many years were you enrolled for SA&DI? Have you passed SA&DI?	Determine the success of the new group designed for SA&D-I.

The questions designed to direct the interviews regarding the research, are listed in Table 5.9. The order of the questions corresponds to the order of guidelines noted in Table 5.4.

All the questions in Table 5.9 have the aim to extract improved ways to address issues in SA&D, with the ultimate purpose to improve the students' experience. Specifically, all questions focused on the focal points utilised by each participant, these varied: from individual participants using all three focal points, to one individual who used them only superficially. The reasons for not using a focal point was interrogated, and the reliance of participants on a particular focus point was questioned. Each question is listed with an accompanying guideline as focus, as well as an endorsing reference.

Table 5.9: List of questions designed to guide interviews to verify and refine the initial guidelines

No.	Question applicable to SMARTguides, Videos, and WhatsApp groups	Guideline focus	Reference
1	How did the technology tool address and convey actual and specific subject matter, which facilitated learning particular to the IT discipline?	Content	Mishra and Koehler (2006)
2	How did the technology tool support SA&D in terms of how the modules are taught, managed, and assessed? How did it support the instilment of values intrinsic to IT? How did its use motivate you to learn?	Pedagogy	Mishra and Koehler (2006)
3	How was the technology tool facilitated in such a way that it was accessible to students?	Technology	Mishra and Koehler (2006)
4	How was the technology tool consistent (within a particular tool or across different tools you used before) and familiar (the first impression of the tool initiated intuitive interaction)?	Consistency and familiarity facilitate learning (1).	Dix *et al.* (2004)
5	How did the technology tool allow you choices to apply personal preference when utilising it?	Flexibility allows for effective use (3).	Hinze-Hoare (2007)
6	How was the technology tool designed to anticipate mistakes?	Prevent mistakes, or allow for its clear identification (4).	Norman (2013)
7	How was error prevention a priority in the design of the technology tool, and when making a mistake, was instructions to handle errors clear and simple?	Allow for recovery from mistakes by returning to a previous state (5).	Shneiderman (1992)
8	Taking into consideration that the technology tool guided you regarding subject matter and the completion of tasks, would you say that you felt as though you were in control of the execution of tasks? Can you supply an example to support your answer?	Capabilities performed according to user intentions (6).	Hinze-Hoare (2007)
9	How did the technology tool address multithreading (allowing interaction of simultaneous tasks), and multimodal dialogue (support of multiple human senses such as colour and sound)?	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7).	Dix *et al.* (2004)
10	How did the technology tool supply timely communication of task status in terms of what the tool is capable of, how to make use of its capabilities, and the expected outcome of actions?	Timely communication of task status (8).	Norman (2013)
11	How did the technology tool assist you in using pre-knowledge and then scaffold new knowledge to obtain an understanding of challenging concepts? Did you actively participate in the learning process involving technology tools?	Pedagogy-content	Mishra and Koehler (2006)
12	How did the technology tool support the user's memory in such a way that a user was expected to remember very little?	Guide users by using physical and logical constraints (2).	Nielsen (1994)
13	How did the technology tool influence the way we presented content?	Technology-content	Mishra and Koehler (2006)
14	How did the technology tool influence the way the teaching and learning of SA&D was conducted?	Technology-pedagogy	Mishra and Koehler (2006)
15	How relevant was the technology tool in the transfer of knowledge amidst bringing together the knowledge of the subject, and how the subject matter was taught and learned?	Technology-pedagogy-content	Mishra and Koehler (2006)

Again, the anticipated direction provided in Table 5.5 is used to guide the success of the implementation of the three focal points in the context of a repeating class. All questions are unstructured and open ended, to allow a response linked to a participant, and questions were formulated to learn from participants without guiding them toward an expected answer. It was anticipated, especially in relation to the TPACK intersections, that participants may confuse a focus because of the complexity of intersection foci. It was therefore not crucial for the researcher to get the correct answer to a particular question, but rather to focus on getting a participant to share all the improvements that may be considered for implementation in the three focal points.

5.7.3 Data collection

With the questions finalised and the content analysis approach outlined, participants were approached for interviewing. From the students who were enrolled as repeating students of SA&D for the period 2015 to 2018, a list of names and contact numbers were compiled. The list were compiled from former students known as candidates who would be able to proficiently articulate their experience. These former students were then contacted via WhatsApp. The first five potential participants who were contacted all agreed to an interview, and appointments were made to suit the candidates.

As planned, each interview session had four parts:

1. Each session was started by welcoming the participant, and emphasising the anonymity of the person. An accompanying "*AUTHORITY FOR SA&D INTERVIEWS AR CYCLE R & N*" (Annexure B) was signed.
2. A discussion explaining the focus of the research, as well as that of the derived HCI foci, and TPACK followed.
3. The initial questions listed in Table 5.8 were asked to gather biographical and background information from participants.
4. The last part of the session addressed the interview. This was the only part that was recorded. The questions listed in Table 5.9 guided the interviews and the focus indicated in Table 5.5 taken into consideration. An introductory question that did not form part of the planned questions, determined which of the three focal points were used by the participant, whether the experience was positive, and why a particular tool was not used if that was the case. The starting and ending time for each code compiled, is listed in "*ACTION RESEARCH CYCLE R – CODE LISTS WITH START*

AND END TIMES" (Annexure C). Coding excerpts listed as footnotes in Table 5.12 were transcribed as verbatim responses.

5.7.4 Participant detail

Table 5.10 lists the five participants, named P1… P5. The table includes the name of the audio file, as well as biographical and background information.

Table 5.10: List of answers to initial questions designed to gather biographical and background information from participants

Participant detail	Preference for class being split	Clear motivation for IT study	Long term vision for IT	Current status	Current job
Participant: P1 Audio file: NL Age: 22 Gender: F Enrolled: 2017, 2018	Positive, added onto existing knowledge, more motivating than re-doing the module.	Wanted to take a gap year to rest, but dad pressured to start studying. Qualified for IT. First year I did not understand the work, but IT started making sense in 2017.	Start own IT business.	BSc IT, final year	N/A
Participant: P2 Audio file: RH Age: 24 Gender: M Enrolled: 2016, 2017	Positive; an opportunity to work (in project groups) with peers who do not want to fail this subject again. Also, it was better than sitting in class with the newcomers, who thought that you have passed.	Third choice (1st – Art, 2nd – Design & 3D modelling). Wants to do game design, which is related.	Be a Games Designer.	BSc IT, final year	Part-time jobs include Programmer, Data Capturer, and Student Assistant.
Participant: P3 Audio file: KM Age: 21 Gender: M Enrolled: 2017, 2018	Positive, liked different approach, it was not a traditional class. The first time I did SA&D I did not understand its significance.	Started with BSc (Computer Science) course, but did not love it (failed all 2nd semester subjects), switched to IT and loves it.	Passionate about programming, would like to work my way up to becoming a project manager.	BSc IT qualified, applying for jobs	In the process of applying for a job as a Programmer.
Participant: P4 Audio file: JW Age: 23 Gender: M Enrolled: 2016, 2017, 2018	Positive, the pressure was less (than the initial semester), this semester was not too busy, and also not too formal.	Initial inspiration was to become a Games Programmer.	Start own IT business.	BSc IT, final year	Part-time job as Games Programmer.

Participant detail	Preference for class being split	Clear motivation for IT study	Long term vision for IT	Current status	Current job
Participant: P5 Audio file: XS Age: 20 Gender: F Enrolled: 2017, 2018	Positive, has done the module before, and therefore I was comfortable and I knew my peers, and they were in the same situation as myself.	IT was not what I wanted to study (1st choice was Pharmacy, 2nd Physiotherapy, 3rd Biochemistry).	Passion lies with data mining (DM), would like to incorporate DM in future studies.	BSc IT, final semester	Work as Student Assistant. In the process to apply for an internship as Systems Analyst.

The participant detail forms the background for the presentation and analysis of the data.

5.7.5 Data presentation and analysis

In an attempt to address trustworthiness (point 4 in Table 5.7), the steps identified in Section 5.7.1 in terms of the data analysis strategy, is followed here.

The ***unit of analysis*** as first step in preparing the data, has been established to be an entire interview with a particular participant. By considering the entire interview as unit of analysis, the researcher could gain an understanding wider than the specific. The interview questions were developed (§5.7.2) from extant literature (Table 5.9). Data was collected (§5.7.3) and participant information related (§5.7.4). Answers to open questions did not relate directly per question, but rather addressed issues on a general level.

Making sense of the data and the whole, involved listening to each interview recording several times while asking questions (*who* (spoke), *where* (did it happen), *when* (did it occur), *what* (happened), and *why* (it happened)). This enabled the researcher to become fully immersed in the data.

Develop an analysis matrix, a process started with the compilation of the initial guidelines which guided the development of the interview questions. The questions guide the categories to verify and refine the guidelines, and to form themes.

Data is gathered by content. Codes were compiled while listening to each interview with the intention to describe all aspects of the interview.

During the first round of analysis, the questions were used to guide the formation of codes, but this strategy did not allow sufficient coding detail to be included. This strategy was amended to rather listen to the voice of participants to include their words in much more detail – as codes. In this way the coding reflects the voice of participants.

Although questions were formulated to learn from the experience of a participant, and care was taken not to guide the participant toward an expected answer, some cases necessitated the use of an example to explain a particular question, or get input regarding an existing idea. All questions were followed up by requesting the participant to share ideas to improve the SA&D subject modules in the context of a specific question.

It was important to hear each participant's voice, and adjust each interview accordingly. In addition, it was anticipated that participants may confuse the TPACK intersection foci and also possibly struggle to distinguish between content and technology–content, as well as pedagogy and technology–pedagogy, since the interviews interrogated the use of technology. In both cases this implied a focus on the intersections rather than the content or pedagogy sphere itself. This situation was accommodated by re-organising the coded data during analysis to allow an answer to match a question, instead of writing up the codes in a chronological order. The argument was that it is important to learn from participants rather than to rigorously apply a data analysis method. This strategy was facilitated by the second attempt to analyse the data and form detailed codes based on participants' voices.

Seaman (1999:567) coined the Glaser and Strauss's constant comparison method "*cross-case analysis*", where field notes from "*cases*" or settings are grouped. In this AR cycle, the codes extracted from a particular interview is treated as a "*case*", allowing four groups of data to be compared in pairs. The first two groups are then compared regarding similarities and differences. Then group 2 and 3 will be compared, and so on, until groups 4 and 5 has been compared.

At the start of each interview, participants were requested to indicate their usage of the three focal points. This knowledge guided each interview. Codes were formulated for the answers to the questions listed in Table 5.9 and are represented in Table 5.11. In the table a bullet (●) represents a response that was expected by the researcher from the context of the situation. Bullets are numbered to ensure traceability. Unexpected responses – from the point of view of the researcher – was indicated with a circle (O) to distinguish it from an expected response. An unexpected response is motivated in a footnote with a corresponding number, with the inclusion of an interview excerpt. When a response of a subsequent participant was added that was not indicated as a response of a participant yet, the content was revisited. Therefore, in all cases, an interview was listened to more than once. In a few instances codes were allocated to more than one question. For all coding occurrences, the codes were tallied, and code totals are shown per question and for each participant per question.

5.7.5.1 Presentation of the codes

The codes are presented in Table 5.11.

Table 5.11: List of codes applied to the interviews done with participants

Question with codes	Participant					Code tally
	P1	P2	P3	P4	P5	
Establish the extent to which the three focal points were used						
I used SMARTguide for examination preparation	[1]○					1
I used SMARTguide to create my own SMARTguide		[2]○				1
I used the SMARTguide to obtain the slides			[3]●			1
I did not find the SMARTguide of much value				[4]●		1
The SMARTguide has value					[5]●	1
I used outcomes (instead of SMARTguide) to ensure all work was covered	[6]●					1
I watched videos selectively	[7]●					1
I watched videos extensively		[8]●		[9]●		2
I did not watch the videos			[10]○		[11]○	2
I also watched YouTube videos	[12]●					1
I used WhatsApp to ask questions	[13]●	[14]●		[15]●	[16]●	4
WhatsApp allowed me immediate access to information	[17]●				[18]●	2

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[1] [P] The first one is the SMARTguide. I did not actually use it until the exams. I didn't. I used the learning outcomes from the book… [I] When you used it for the exams, why did you use it, what was your motivation? [P] Because I wanted to make sure I understand everything. That it is the same as the outcomes. That is why I used it when I was studying. And it actually helped.

[2] [P] I would make my own type of SMARTguide, for instance, I would go through the textbook, and summarise it for myself in the same way, just it is easier to memorise everything if you do it that way. But, I did go through the SMARTguide to get a layout of what the chapter would look like.

[10] [P] I believe the most determining factor is that background thing I talked about… having a mentality of survival really impacts the way you do things in a sense you end up doing things just for the sake of doing them, instead of doing things perfectly… I always felt that 50% is enough. I do not need more. That is what I need to pass and I could see how my background affected that. I started feeling I need to do things more perfectly, I need to start paying more attention to detail, I need to start being more accurate. That happened at a later stage… when I was about to finish (my course). Our final year was comfortable compared to the earlier years; we had food, accommodation was paid for, a lot of stuff. Before then I worried about eating, I worried about res (residence), I worried about a lot of things. Yes, I saw that many students do have the potential to be excellent, but because we have this survival mentality it affected the way we conducted ourselves.

[11] [I] And, (did you use) the videos? [P] The videos, I don't want to lie, not at all… [I] Is it something that you do not tend to use in general? [P] In general, even for other subjects as well. If it is like videos, ah-ah. With systems for me it is more theory, unless it is a calculation I do not understand, then maybe … I will search for videos. [I] You will rather get an example from the book and work through that? Work through that. That was easier.

Question with codes	Participant					Code tally
	P1	P2	P3	P4	P5	
The WhatsApp group helped me to compare my progress	[19]●					1
SA&D introduced the use of WhatsApp for study purposes	[20]●	[21]●		[22]●	[23]●	4
I absorbed information on the WhatsApp groups, but I did not participate			[24]●		[25]●	2
TOTAL	8	4	3	4	6	25
Q1: How did the technology tool address and convey actual and specific subject matter, which facilitated learning particular to the IT discipline?						
The SMARTguide should include the videos				[26]●		1
Videos should address more complex issues as well				[27]●		1
The WhatsApp groups should encourage deeper discussions			[28]○			1
I asked friends to ask my questions on WhatsApp					[29]○	1
I would follow up on group conversations with individuals					[30]○	1
Chances of getting a response on WhatsApp is good					[31]●	1
In addition I created my own learning tools				[32]●		1
TOTAL	0	0	1	3	3	7
Q2: How did the technology tool support SA&D in terms of how the modules are taught, managed, and assessed? How did it support the instilment of values intrinsic to IT? How did its use motivate you to learn?						
The SMARTguide should include more guidance on self-assessment questions	[33]●					1
The SMARTguide should include more guidance on what to include in the project documentation		[34]●				1
The SMARTguide should include more guidance on what to include in the project prototype		[35]●				1
Balance the level of assistance to students to encourage learning from experience to develop skills		[36]○				1

[28] [P] I was on the (WhatsApp) groups. I never communicated. I did not say anything. I believe (the WhatsApp groups) are very effective in a sense of giving maybe updates on tests, and discussing tests and maybe activities, but not really tackling topics. Most of the time I saw one answer to one question, which I felt was not quite enough. Maybe I want different perspectives, not just one perspective from my lecturer, but I want a perspective from my peers as well. Normally that would not happen to a degree where I feel, okay we are having an exchange of information. I do not believe information flows as it is supposed to flow.

[29] [P] At times you would not understand something and maybe as I was about to ask, another student will ask the same question or maybe point (an aspect) out, and then I will say: "oh, okay it is like this", so the WhatsApp group is a really good way for us students to help each other out… The WhatsApp group, it really helps a lot. Even though sometimes you would be like shy to ask certain questions on the group, like you just wait for someone to ask the same question, or at times I would text my friend, I am like – ask this question on the group… I did participate, but anonymously… somehow. (I lacked) the confidence to just type something and send it to like a lot of people… what if, you know, people have different opinions, and what if you ask a certain question and they think: "this person is not studying, why would they ask such a question?".

[30] [P] At times I… would text a person privately: "so, how did you come about getting this answer… ". So, I would extend the conversation, but privately.

[36] [P] One thing I do want to mention however is; I feel there should be a fine balance between helping students and not helping them. [I] Yes, I agree with you. [P] A lot of what made you make learn things is figuring it yourself. [I] Especially in our environment.

Question with codes	Participant					Code tally
	P1	P2	P3	P4	P5	
Baseline tests are not working as well as testing what has been taught at the end of a formal class		[37] ○				1
Improved communication may help students to understand the motivation behind the SA&D teaching approach		[38] ●	[39] ●			2
Relate to students with problems			[40] ●			1
Appointment of an assistant to mentor project groups with such a need			[41] ●			1
TOTAL	1	5	3	0	0	9
Q3: How was the technology tool facilitated in such a way that it was accessible to students?						
There was sufficient support for students to access the technology tools	[42] ●	[43] ●				2
Ease of download/installation of SMARTguide to be improved	[44] ●			[45] ●	[46] ●	3
Make students aware that they can use WhatsApp in collaboration with Google Drive		[47] ○				1
Discord may work well as instant messaging tool since it allows voice conferencing among group members				[48] ○		1
Make students aware of tools to manage version control		[49] ○				1
The lecturer should restrict the usage of WhatsApp to manage diversions	[50] ●	[51] ●	[52] ●			3
Enlist the help of additional administrators to moderate the group		[53] ●				1
Remove students who divert from the group focus – after a warning	[54] ●	[55] ●				2
Consider creating two WhatsApp groups, one allowing members to talk and another to post important messages		[56] ●				1
Create WhatsApp group early in semester – it is a reminder to prepare for assessments	[57] ●					1
Videos were easy to download	[58] ●	[59] ●		[60] ●		3

[P] Yes. So, it is nice to help students, but not too much, because, yes you will be able to do it but not figuring it out yourself is going to hinder your capability to learn from the experience. For instance, a good example is our database project: we got a picture as the scope and we had to figure it out. We were not guided in any way, but from that experience you learned a lot.

[37] [P] ... the class test we wrote every week, we didn't get that in the repeater class. And the problem I had with the class tests were, we were writing a class test, but then only covering the chapter on that class test afterwards. I understand the concept you have to prepare for that chapter at home, but in my mind students would pay attention throughout the entire lecture if the class test would be at the end of it. Everyone is going to be sitting there paying very good attention to the lecture.

[47] [P] Uhm, for adjustment, I would make a slight adjustment to the WhatsApp thing. WhatsApp has a feature where; let's say I send a document on WhatsApp, I can save it to a Google Drive, so I could suggest that you make a Google Drive account specifically for the WhatsApp group. And then you can put folders and stuff in it and then you can, from the WhatsApp group save the documents and stuff you want to use onto the Google Drive. It works just easier to access on a PC afterwards.

[48] [P] The WhatsApp group… what if we made these groups available on more platforms, like Discord. It is almost like a hybrid between Skype and WhatsApp. Voice conferences would be a lot easier.

[49] [P] It simulates the (IT) environment quite well. The only thing it does not however do, is let's say you are working on a project together. There is no repository where all of you can work together and share your stuff on the same part of your project... They taught us how to do this in Expert Systems.

Question with codes	Participant					Code tally
	P1	P2	P3	P4	P5	
TOTAL	6	8	1	3	1	19
Q4: How was the technology tool consistent (within a particular tool or across different tools you used before) and familiar (the first impression of the tool initiated intuitive interaction)?						
SMARTguide itself is easy to use	[61]●	[62]●	[63]●	[64]●	[65]●	5
Videos were easy to use	[66]●	[67]●		[68]●		3
I am comfortable with WhatsApp since I use it every day	[69]●	[70]●	[71]●	[72]●	[73]●	5
TOTAL	3	3	2	3	2	13
Q5: How did the technology tool allow you choices to apply personal preference when utilising it?						
I can easily utilise the SMARTguide on my tablet		[74]●				1
I only used the SMARTguide on eFundi					[75]●	1
I can easily utilise the videos on my tablet		[76]●				1
Videos allowed me to learn in a practical way				[77]●		1
I could watch videos at different speeds				[78]●		1
I muted our WhatsApp group when I needed no interruptions	[79]●				[80]●	2
Within WhatsApp I had a variety of communication options	[81]●					1
I use WhatsApp on my PC through WhatsApp Web or a mobile phone emulator		[82]●				1
TOTAL	2	3	0	2	2	9
Q6: How was the technology tool designed to anticipate mistakes?						
I was hesitant to post messages on the WhatsApp group because I feared making a mistake					[83]●	1
Lecturer should make students aware of potential mistakes to be made on WhatsApp	[84]●					1
Lecturer should set rules for the use of the WhatsApp group	[85]●		[86]●			2
I pinned our WhatsApp group – to prioritise it on the application	[87]○					1
TOTAL	3	0	1	0	1	5
Q7: How was error prevention a priority in the design of the technology tool, and when making a mistake, was instructions to handle errors clear and simple?						
One cannot make mistakes when using the SMARTguide	[88]●	[89]●			[90]●	3
One cannot make mistakes when using the videos	[91]●	[92]●				2
A SMARTguide that is corrupted or deleted may be downloaded again				[93]●		1
When a video is corrupted or deleted it is easy to download again				[94]●		1

[87] [I] Did you ever post a message that was not meant for the group, by accident? [P] No, no, no, the thing is I actually pinned the group. I could see everything and made sure I did not send another message. [I] So, it was one of your important groups? [P] Yes it was. So, I did not send a message if it was not about the subject and nothing else.

Question with codes	Participant					Code tally
	P1	P2	P3	P4	P5	
On WhatsApp you can remove yourself by accident, but the lecturer can add you again	[95] ●				[96] ●	2
WhatsApp did not allow me to delete a message intended for another recipient but sent on the group	[97] ●	[98] ●		[99] ●	[100] ●	4
TOTAL	4	3	0	3	3	13
Q8: Taking into consideration that the technology tool guided you regarding subject matter and the completion of tasks, would you say that you felt as though you were in control of the execution of tasks? Can you supply an example to support your answer?						
The user determines how the technology tools are used	[101] ●					1
An individual may decide which tools (technology and otherwise) to use to achieve a goal	[102] ●					1
I find WhatsApp to be non-intrusive, I can attend to messages when it is convenient for me				[103] ●		1
TOTAL	1	0	0	1	0	3
Q9: How did the technology tool address multithreading (allowing interaction of simultaneous tasks), and multimodal dialogue (support of multiple human senses such as colour and sound)?						
An individual may decide which tools (technology and otherwise) to use to achieve a goal	[104] ●				[105] ●	2
The three technology tools work perfectly in conjunction with one another	[106] ●	[107] ●			[108] ●	3
I would ask questions on a topic after I watched a video				[109] ●		1
Three technology tools worked well with other tools	[110] ○					1
I could ask questions on a topic I still did not understand after class					[111] ●	1
The SMARTguide is appealing to the eye					[112] ●	1
Video drawings may be amended to be clearer using Draw.io		[113] ●				1
Discord may work well as instant messaging tool since it allows voice conferencing among group members				[114] ●		1
Within WhatsApp I had a variety of communication options	[115] ●					1
TOTAL	4	2	0	2	4	12
Q10: How did the technology tool supply timely communication of task status in terms of what the tool is capable of, how to make use of its capabilities, and the expected outcome of actions?						
Technology tools are all basic with good built-in feedback	[116] ●					1
WhatsApp in particular gives feedback in such a way that one can identify a problem				[117] ○		1

[110] [P] I remember I was in a taxi, coming here from Johannesburg, it was a long drive, and then the group was talking about something, and then I have my textbook on my phone. So, I was actually going back to my phone… going back to my book to verify, I actually felt like I was in class.

[117] [P] I like how WhatsApp does it, because it kind of tells you if something goes wrong, at what point it went wrong. When something goes wrong at the stopwatch looking icon… the problem is on your side, and it is probably an Internet connection problem. If it is the one mark and you never get the two marks then it means it is the cell phone tower is down… [I] Or, the person

Question with codes	Participant					Code tally
	P1	P2	P3	P4	P5	
TOTAL	1	0	0	1	0	2
Q11: How did the technology tool assist you in using pre-knowledge and then scaffold new knowledge to obtain an understanding of challenging concepts? Did you actively participate in the learning process involving technology tools?						
It was important to use the tools made available	[118] ●	[119] ●				2
Improvement – show a video snippet in class to make students aware of its existence	[120] ○					1
Students should be made aware of available help: on eFundi and WhatsApp		[121] ●				1
All challenging concepts were addressed in some form	[122] ●	[123] ●				2
I would have preferred more complex video topics				[124] ○		1
TOTAL	3	3	0	1	0	7
Q12: How did the technology tool support the user's memory in such a way that a user was expected to remember very little?						
I used the SMARTguide sequentially – to ensure I cover all material	[125] ●					1
Too much information in the SMARTguide may defy the purpose		[126] ●				1
I watched a video more than once – to ensure I understand the concept fully	[127] ●					1
Self-made videos are important		[128] ●				1
The videos afforded me only a basic understanding of challenging concepts				[129] ●		1
I used WhatsApp when I had a question	[130] ●					1
I found the WhatsApp groups to be professional and not cluttered with nonsense				[131] ●		1
At times the WhatsApp group conversations were overwhelming					[132] ●	1
Multiple WhatsApp conversations were not supported by the quote-feature (➥)		[133] ●				1
A WhatsApp group where only the administrator(s) may send message may minimise clutter		[134] ●				1

that you are sending it to… does not have data. [P] Yes, of course… And when both marks are grey and it stays like that for a really long time in a group chat, then you know that, okay someone in the group did not read the message, but everyone got the message. So, if they do not read the message it is kind of their fault.

[120] [P] I think you should tell them that you made videos and maybe show it in class, like a portion of the video so that they can decide whether they need it or not. Just a portion, maybe 5 minutes or so. So now, when they study and they do not understand something, they will be like: "let me check the videos I saw in class". But, then it will be up to them.

[124] [P] I did struggle a lot with the theoretical part, so the videos were definitely like a relief almost… I felt like that was almost the easier parts of the module … personally I do not think I would have done. I probably would have gotten zero for the modules for the first and second year of when I repeated it … but the videos were a massive help, the videos definitely helped a lot. [I] Maybe you can react to what I am saying now… my perception is, because you were so reliant on the videos, you wanted more difficult videos, it would have bridged that gap you had to fill. [P] I mean, unrealistically I would have loved it if all of the work was on video, like everything, but that is a bit unrealistic.

Question with codes	Participant					Code tally
	P1	P2	P3	P4	P5	
A second WhatsApp group allowing informal chats among students may be formed		[135] ●				1
TOTAL	3	5	0	2	1	11
Q13: How did the technology tool influence the way we presented content?						
The SMARTguide may be more interactive in terms of guidance				[136] ●		1
Self-made videos are important		[137] ●				1
The videos in SA&D motivated me to incorporate (YouTube) videos in my studies	[138] ●					1
SA&D made me aware that WhatsApp can be a good tool to support my studies	[139] ●	[140] ●				2
WhatsApp allows discussion among peers				[141] ●		1
In WhatsApp, peer-to-peer explanations have much value				[142] ●	[143] ●	2
Technology makes our (SA&D) life easier		[144] ●				1
Technology allows one to share information directly, in a fast and easy way, but in your own time and at your own pace				[145] ●		1
TOTAL	2	3	0	4	1	10
Q14: How did the technology tool influence the way the teaching and learning of SA&D was conducted?						
When I missed a class, the technology tools helped me to catch up	[146] ●					1
When I studied alone, the technology tools supported me sufficiently	[147] ●					1
The three technology tools simulated the teaching environment well	[148] ●	[149] ●		[150] ●	[151] ●	4
A video is almost like a lecture, but I can do it in my own time and watch it more than once	[152] ●			[153] ●		2
TOTAL	4	1	0	2	1	8
Q15: How relevant was the technology tool in the transfer of knowledge amidst bringing together the knowledge of the subject, and how the subject matter was taught and learned?						
The IT course clicked for me in 2nd year	[154] ●					1
The technology tools extended our class	[155] ●				[156] ●	2
I could decide how and what to learn					[157] ●	1
My generation needs competition in teaching and learning – SA&D becomes interesting					[158] ○	1
When formalities are removed, we as students learn					[159] ○	1

[158] [P] With our generation, if you make things fun… you create a buzz… Even though systems may be overwhelming, it is a really cool and really interesting subject. With our generation, competition brings out the best results ever. Once you add fun into it, once we do things we like…

[159] [P] I feel like, another reason why we were able to like utilise it and be more comfortable with it, with students, when … okay, I do not know with other students, but with me, when I look at eFundi, it is so formal sort of type of a thing, it is so formal – looking at our generation if you use the things that we are into at the moment, and use them like in education, or maybe trying to teach us something we are already comfortable with that thing and we will really see it as something that is cool, so we are going to use it,

Question with codes	Participant					Code tally
	P1	P2	P3	P4	P5	
The games we played in class motivated me	[160]●				[161]●	2
TOTAL	3	0	0	0	5	8

5.7.5.2 Analysis of the codes

Grouping of the data, and applying abstraction had the purpose to form themes from categories that extend meaning regarding the research. A first round of abstraction grouped all codes to form themes. Upon reflection, it was decided to only utilise codes not mapped to the initial guidelines to form categories and themes. Two themes with its associated categories and the codes associated per category is presented as network diagrams in Figure 5.5 and Figure 5.6. These codes were the ones not mapped to Table 5.12 – where the initial guidelines are in the process of being verified and refined. Related codes which belong together to describe a phenomenon, were grouped to form categories. The construction of the description was adjusted to fit in with other descriptions identifying a category.

Among the interviewed participants, everybody found the WhatsApp groups of value, although to various degrees. Three participants (P1, P2, P4) were comfortable using this platform, while one participant (P5) utilised it, but by asking friends to ask her questions on her behalf. One participant (P3) joined the groups, but only listened in, and did not contribute. The videos were also utilised well, although one participant (P5) preferred not to view them, and one participant (P3) was not aware of them. One participant (P4) admitted being very reliant on the videos to help him make sense of the material. Even though participants indicated that they under-utilised the SMARTguides, all participants did refer to it for some academic purposes. Its use varied from accessing it only to obtain the link to the slides (P3), to creating an own SMARTguide for learning purposes (P2).

saying <snap of fingers>: "Ooh, okay, we are studying via WhatsApp, that is so awesome". ... So, with us young people, if you take something that we are into and you use it, like you remove whatever formal tools, formalities, if you remove formalities, we become really comfortable, because we are all relaxed and we are comfortable, and we use the platform and in that way we learn. … We have to make sure it (a tool) is something students are into. It must not be formal…

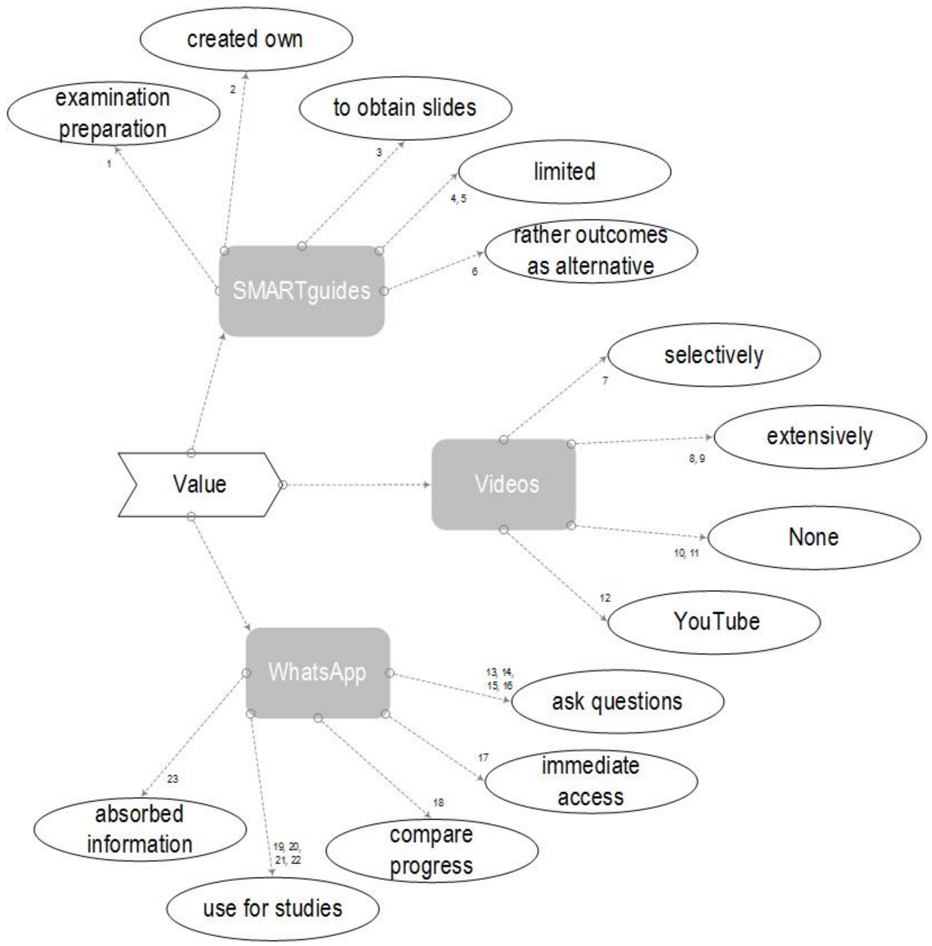


Figure 5.5: Network diagram showing theme "Value of the focal points", with its categories, each with grouped codes

During the course of the interviews three suggestions came to the fore. During each discussion it was established that because of either the size of the group, or the nature of the software suggested to be used, the suggested software are not applicable to the three focal points. It was decided that it would be helpful to make future students aware of these applications, and the functionality they provide.

Suggestions include:

- Participant 2 suggested that a Google Drive account should be linked to a WhatsApp group. Although this is not practical for the class group, this may work well in the context of the smaller project groups. This addition would facilitate the sharing of files.
- Participant 4 suggested the use of Discord, an application initially developed for the use of people playing games. Discord is combining features of WhatsApp and Skype and may facilitate voice conferencing among smaller groups, such as the project groups.

- Participant 2 expressed the need for version control software. He did recognize that he does not anticipate it to be used in SA&D, but felt that students should be made aware of it.

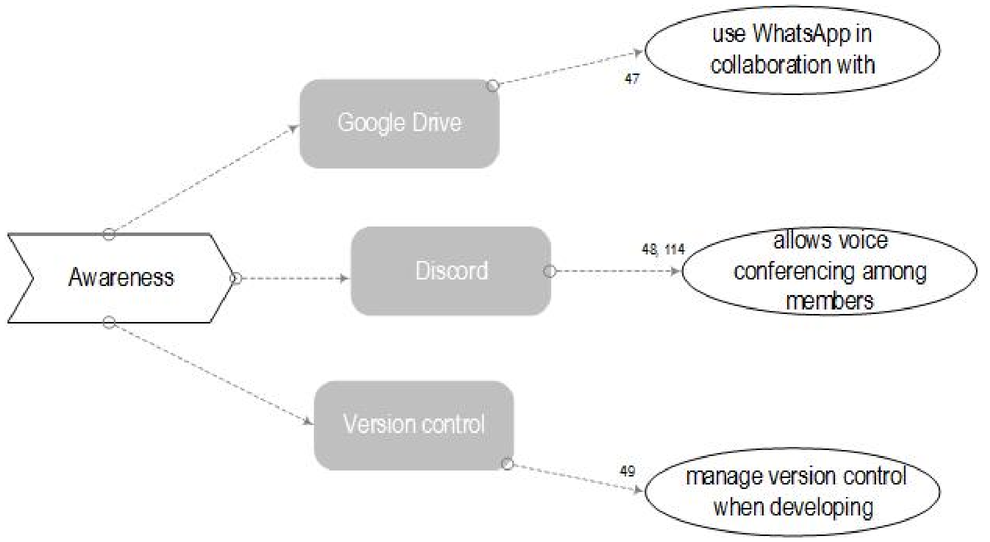


Figure 5.6: Network diagram showing theme "Awareness", with its categories, each with grouped codes

The remaining codes are now mapped to the initial guidelines (the analysis matrix obtained from Chapter 4) in Table 5.12. The focus is on indicating all codes that are either in support of a particular guideline, or are causing problems with regard to a particular guideline. The purpose of this step is to verify and refine the initial guidelines.

Table 5.12: Codes mapped to the initial guidelines

Knowledge	Initial guideline	Impact	
		In support	A problem
Content	Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge.	29 I asked friends to ask my questions on WhatsApp 30 I would follow up on group conversations with individuals 31 Chances of getting a response on WhatsApp is good 32 In addition I created my own learning tools	26 The SMARTguide should include the videos 27 Videos should address more complex issues as well 28 The WhatsApp groups should encourage deeper discussions

Knowledge	Initial guideline	Impact	
		In support	A problem
Pedagogy	The identification of teaching (and learning) approaches is paramount in support of the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.	[37] Balance the level of assistance to students to encourage learning from experience to develop skills	[33] The SMARTguide should include more guidance on self-assessment questions [34] The SMARTguide should include more guidance on what to include in the project documentation [35] The SMARTguide should include more guidance on what to include in the project prototype [36] Baseline tests are not working as well as testing what has been taught at the end of a formal class [38, 39] Improved communication may help students to understand the motivation behind the SA&D teaching approach [40] Relate to students with problems [41] Appointment of an assistant to mentor project groups with such a need
Technology	The preparation of a technology tool requires technological know-how on the part of the lecturer. Its accessibility is of importance. Directions regarding its download, and assistance may support the accessibility of downloads. The HCI foci listed are applicable to the technology sphere.	[42, 43] There was sufficient support for students to access the technology tools [58, 59, 60] Videos were easy to download	[44, 45, 46] Ease of download/installation of SMARTguide to be improved [50, 51, 52] The lecturer should restrict the usage of WhatsApp to manage diversions [53] Enlist the help of additional administrators to moderate the group [54, 55] Remove students who divert from the group focus – after a warning [56] Consider creating two WhatsApp groups, one allowing members to talk and another to post important messages [57] Create WhatsApp group early in semester – it is a reminder to prepare for assessments

Knowledge	Initial guideline	Impact	
		In support	A problem
	HCI focus		
	Consistency and familiarity facilitate learning (1). The selection of technology tools should favour familiarity. In combination with simplicity and consistency regarding look & feel, movement, uses, speed of operation, and status indication within a technology tool, the user is allowed to become familiar with it in a short timeframe.	[61, 62, 63, 64, 65] SMARTguide itself is easy to use [66, 67, 68] Videos were easy to use [69, 70, 71, 72, 73] I am comfortable with WhatsApp since I use it every day	- -
	Flexibility allows for effective use (3). Flexibility regarding access to learning material is important, and a technology tool should be accessible via a variety of platforms (mobile, laptop, desktop) and modes (online, offline; sequentially and direct). Some knowledge of the underlying technology is necessary to ensure flexibility of use.	[74] I can easily utilise the SMARTguide on my tablet [75] I only used the SMARTguide on eFundi [76] I can easily utilise the videos on my tablet [77] Videos allowed me to learn in a practical way [78] I could watch videos at different speeds [79, 80] I muted our WhatsApp group when I needed no interruptions [81] Within WhatsApp I had a variety of communication options [82] I use WhatsApp on my PC through WhatsApp Web or a mobile phone emulator	- -
	Prevent mistakes, or allow for its clear identification (4). The use of technology tools should be directed with clear information.	[87] I pinned our WhatsApp group – to prioritise it on the application	[83] I was hesitant to post messages on the WhatsApp group because I feared making a mistake [84] Lecturer should make students aware of potential mistakes to be made on WhatsApp [85, 86] Lecturer should set rules for the use of the WhatsApp group

Knowledge	Initial guideline	Impact	
		In support	A problem
	Allow for recovery from mistakes by returning to a previous state (5). It should be quick and easy to recover from mistakes occurring with regard to the use of a technology tool. Mistakes include the corruption of either the application, or a file (in the case of a video), and sending a message to the wrong group, or with the wrong intention.	[88, 89, 90] One cannot make mistakes when using the SMARTguide [91, 92] One cannot make mistakes when using the videos [93] A SMARTguide that is corrupted or deleted may be downloaded again [94] When a video is corrupted or deleted it is easy to download again [95, 96] On WhatsApp you can remove yourself by accident, but the lecturer can add you again	[97, 98, 99, 100] WhatsApp did not allow me to delete a message intended for another recipient but sent on the group
	Capabilities performed according to user intentions (6). A technology tool designed or selected to guide teaching and learning should allow a user to use it to the user's intentions. In addition, when more than one technology tool is made available, a user should be able to use the ones fit for a task.	[101] The user determines how the technology tools are used [102] An individual may decide which tools (technology and otherwise) to use to achieve a goal [103] I find WhatsApp to be non-intrusive, I can attend to messages when it is convenient for me	- -
	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7). A task a user needs to perform, should involve a dialogue thread. The improvement of computer interfaces for use by humans should be based on measuring human perception, where humans perceive their environment through their senses (see, hear, touch, smell, taste).	[104, 105] An individual may decide which tools (technology and otherwise) to use to achieve a goal [106, 107, 108] The three technology tools work perfectly in conjunction with one another [109] I would ask questions on a topic after I watched a video [110] Three technology tools worked well with other tools [111] I could ask questions on a topic I still did not understand after class [112] The SMARTguide is appealing to the eye [115] Within WhatsApp I had a variety of communication options	[113] Video drawings may be amended to be clearer using Draw.io
	Timely communication of task status (8). Sensitivity towards status feedback regarding a technology tool should be encouraged.	[116] Technology tools are all basic with good built-in feedback [117] WhatsApp in particular gives feedback in such a way that one can identify a problem	- -

Knowledge	Initial guideline	Impact	
		In support	A problem
Pedagogy-content	Content should be taught in a way which conveys the message of the material learned. Typically, a particular technology tool would support only a part of the overall approach. The HCI foci listed are applicable to the pedagogy-content intersection.	[122, 123] All challenging concepts were addressed in some form	[118, 119] It was important to use the tools made available [120] Improvement – show a video snippet in class to make students aware of its existence [121] Students should be made aware of available help: on eFundi and WhatsApp [124] I would have preferred more complex video topics
	HCI focus		
	Guide users by using physical and logical constraints (2). The use of computer power and availability to guide user progression in using a technology tool.	[125] I used the SMARTguide sequentially – to ensure I cover all material [126] Too much information in the SMARTguide may defy the purpose [127] I watched a video more than once – to ensure I understand the concept fully [128] Self-made videos are important [130] I used WhatsApp when I had a question [131] I found the WhatsApp groups to be professional and not cluttered with nonsense	[129] The videos afforded me only a basic understanding of challenging concepts [132] At times the WhatsApp group conversations were overwhelming [133] Multiple WhatsApp conversations were not supported by the quote-feature (➥) [134] A WhatsApp group where only the administrator(s) may send message may minimise clutter [135] A second WhatsApp group allowing informal chats among students may be formed
Technology-content	Although technology typically does not constrain the transfer of large parts of material, it should facilitate the presentation of small portions of information to direct learning when needed.	[137] Self-made videos are important [138] The videos in SA&D motivated me to incorporate (YouTube) videos in my studies [139, 140] SA&D made me aware that WhatsApp can be a good tool to support my studies [141] WhatsApp allows discussion among peers [142, 143] In WhatsApp, peer-to-peer explanations have much value [144] Technology makes our (SA&D) life easier [145] Technology allows one to share information directly, in a fast and easy way, but in your own time and at your own pace	[136] The SMARTguide may be more interactive in terms of guidance

Knowledge	Initial guideline	Impact	
		In support	A problem
Technology-pedagogy	Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.	[146] When I missed a class, the technology tools helped me to catch up [147] When I studied alone, the technology tools supported me sufficiently [148, 149, 150, 151] The three technology tools simulated the teaching environment well [152, 153] A video is almost like a lecture, but I can do it in my own time and watch it more than once	- -
Technology-pedagogy-content	In support of a lecturer, technology should be a channel for content presented in a way through which students will best internalise concepts.	[154] The IT course clicked for me in 2nd year [155, 156] The technology tools extended our class [157] I could decide how and what to learn [158] My generation needs competition in teaching and learning – SA&D becomes interesting [159] When formalities are removed, we as students learn [160, 161] The games we played in class motivated me	- -

5.7.5.3 The findings following from the analysis

The success of the intervention in terms of the "*Value of the focal points*" to the participants, are:

1. All participants did refer to the SMARTguides for some academic purposes, albeit in an under-utilised way. Two extreme uses was only to obtain the link to the slides, versus creating an own SMARTguide for learning purposes.
2. The videos were utilised well, with one participant being very reliant on them. On the other side of the spectrum one participant preferred not to view videos, and another was not aware of uploaded videos.
3. All participants found the WhatsApp groups of value. Three participants were confident in its use, while one participant utilised it by asking friends to ask her questions, and another joined the groups, but only listened in.

Participants recommended three useful applications. Although they are used in advanced situations and are applicable to the smaller project groups, it may have value to create awareness regarding:

- A Google Drive account which may be linked to a WhatsApp group. This addition would facilitate the sharing of files and its version control.
- Discord, which combines features of WhatsApp and Skype to facilitate voice conferencing.
- Software that facilitates version control of developed programs.

Subsequently "*the story which the data tell*", is related. Table 5.12 and Figure 5.6 is referred. The knowledge gained is related in blocks as pre-defined updated guidelines. The findings that result from the implementation of the suggested guideline amendment is shown in Table 5.13, in the subsequent section.

Guideline content: participants indicated that two of the focal points (videos and WhatsApp) addressed basic concepts well, but lacked when explaining more complex scenarios. Code occurrences 27-28 refer. The **suggested guideline amendment** reads as follows:

> Provision should be made for a variety of challenges per concept addressed in the utilisation of technology tools, addressing easy examples, intermediate examples, as well as complex examples.

Guideline technology: from the data analysed, the most prominent aspect to take into consideration when introducing technology into an educational environment – when such technology was not designed for an educational environment – is for the educator to identify where the tool lacks and then to take the responsibility to guide and manage its usage according to the purpose for which the tool is used. Code occurrences 50-56 refer. Also important, is to make students aware of technology that may be useful in a particular context of the work they are expected to do. Figure 5.6 refers. The **suggested guideline amendment** reads as follows:

> Technology tools introduced should be amended with non-technical support and measures to ensure it is effectively used in an educational environment.

Derived HCI focus 4 (Prevent mistakes, or allow for its clear identification): in support, the identification of potential mistakes, are important. Code occurrences 83-86 refer. The **suggested guideline amendment** reads as follows:

> In an educational environment students should be sensitised regarding potential mistakes that may occur to facilitate unhindered use of technology tools.

Derived HCI focus 7 (Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses): participants indicated that multithreading extends beyond technology tools to other educational tools to achieve a goal. This extension may cover multimodality beyond the electronic as well. Code occurrences 104-111 refer. The **suggested guideline amendment** reads as follows:

> Multithreading and multimodality should be cultivated by combining technology and non-technical tools in an educational environment.

Guideline pedagogy-content: participants felt that students need to be made aware of the value of the three focal points. The code occurrences 120-121 refer. The **suggested guideline amendment** reads as follows:

> In an educational context, awareness regarding technology tools should be created repeatedly through various measures.

Guideline technology-content: one participant expressed a need for the SMARTguide to be more interactive. The code occurrence 136 refers. The **suggested guideline amendment** reads as follows:

> Interactivity should be paramount in the mind of an educator when creating and utilising technology tools.

Reporting in the findings, and the ***reflection on trustworthiness*** is done in the section on learning specified that follows.

5.8 AR CYCLE R – LEARNING SPECIFIED

At the start of this chapter, it was anticipated that learning specified will centre on solving a real-world problem (P) of teaching the subject modules of SA&D to **repeating** IT students. The focus was on the three cases of technological instruments of instructional design using SMARTguides, formative guidance using Videos, and summative assessment using WhatsApp (M_{PS}). It had the purpose to emancipate repeating students – to enable them to reach their full potential (M_{PS}). Feedback from participants will direct future instructional design to enable emancipation. The focus will be in the areas of "*Value of the focal points*", and "Awareness". The AR method (M_R) was applied to the problem. The HCI principles and the framework for technological pedagogical content knowledge (M_R) guided interviews. The primary goal of this chapter, namely to verify and refine the initial guidelines formulated from literature, was achieved – through the successful application of an AR cycle.

From the mapping that was done on the initial guidelines – in Table 5.12, the preceding discussion facilitated the formulation of the updated HCI-TPACK guidelines listed in Table 5.13. The formulation takes the impact into consideration, both in the case of problems presented and aspects in support of the focal points. The intention is to improve the real-world environment regarding the three focal points, as well as future technological implementations.

To emphasize the update, a guideline that has been changed, is shown in *italics*, and one amended is shown in **bold**.

Table 5.13: Updated HCI-TPACK guidelines

Knowledge	Updated guideline
Content	Content should be presented in small portions which are is easily and directly accessible, with reference to more in-depth sources of knowledge **to address more complex problems.**
Pedagogy	The identification of teaching (and learning) approaches is paramount in guiding the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.
Technology	*The inclusion of technology tools requires ensuring its accessibility and therefore guidance in its use, and support regarding its download to a variety of platforms.* **Additional non-technical measures should be considered when utilising technology tools not intended for teaching and learning.** The HCI foci listed are applicable to the technology sphere.
	HCI focus
	Consistency and familiarity facilitate learning (1). The selection of technology tools should favour familiarity. In combination with simplicity and consistency regarding look & feel, movement, uses, speed of operation, and status indication within a technology tool, the user is allowed to become familiar with it in a short timeframe.
	Flexibility allows for effective use (3). Flexibility regarding access to learning material is important, and the technology tools should be accessible via a variety of platforms (mobile, laptop, desktop) and modes (online, offline; sequentially and direct). Knowledge of the underlying technology tool is also necessary to ensure its flexibility of use.

Knowledge	Updated guideline
	Prevent mistakes, or allow for its clear identification (4). The use of technology tools should be directed with clear information *included in the tool*. Additional non-technical measures may be necessary when utilising technology tools not intended for teaching and learning – to prevent mistakes.
	Allow for recovery from mistakes by returning to a previous state (5). It should be quick and easy to recover from mistakes occurring with regard to the use of a technology tool. Mistakes include the corruption of either the application, or a file (in the case of a video), and sending a message to the wrong group, or with the wrong intention.
	Capabilities performed according to user intentions (6). A technology tool designed or selected to guide teaching and learning should allow a user to use it to the user's intentions. In addition, when more than one technology tool is made available, a user should be able to use the ones fit for a task. Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7). A task a user needs to perform, should involve a dialogue thread. The improvement of computer interfaces for use by humans should be based on measuring human perception, where humans perceive their environment through their senses (see, hear, touch, smell, taste). In an educational context technology tools should support non-technology tools in achieving a goal.
	Timely communication of task status (8). Timely communication of task status should be supported by technology tools. In addition, it is important to create awareness to be sensitive towards status feedback regarding the technology tools.
Pedagogy-content	Content should be taught in a way which conveys the message of the material learned. Typically, a particular technology tool would support only a part of the overall approach. In an academic context, students should be made aware of the existence of technology tools, the value of each tool, and how to use it in conjunction with non-technical tools. The HCI foci listed are applicable to the pedagogy-content intersection.
	HCI focus
	Guide users by using physical and logical constraints (2). The use of computer power and availability to guide user progression in using a technology tool.
Technology-content	Although technology typically does not constrain the transfer of large parts of material, *the presentation of small portions of interactive in-context material to direct learning when needed, should be the focus when using it for teaching and learning purposes.*
Technology-pedagogy	Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.
Technology-pedagogy-content	In support of a lecturer, technology should be a channel for content presented in a way through which students will best internalise concepts.

Establish trustworthiness. The list of questions formulated above (Table 5.7), has been utilised to reflect on its implementation in Table 5.14.

Table 5.14: Trustworthiness verification list used to guide content analysis

No.	Question to guide trustworthiness	Motivation with references
1	Is the process of analysis as well as the ensuing results described in enough detail?	Dissected analysis was described in §5.7.5, and strengths/restrictions highlighted to motivate results.

No.	Question to guide trustworthiness	Motivation with references
2	Are the themes described by its categories, and categories by its codes?	Descriptions of themes and categories were done in §5.7.5.2 (illustrated by Table 5.12, Figure 5.4 and Figure 5.5), and codes in §5.7.5.1 (illustrated by Table 5.11).
3	Do the groupings cover the data well?	Description of groupings was done in §5.7.5.2 (illustrated by Figure 5.4 and Figure 5.5), and the mapping of codes to initial guidelines in §5.7.5.2 (illustrated by Table 5.12).
4	Are the context, the participants, data collection, and analysis process described thoroughly?	Descriptions of the context are found in §5.3, §5.4 and §5.5, participants in §5.7.4 (illustrated by Table 5.10), data collection in §5.7.3 (illustrated by Table 5.9), and the analysis process in §5.7.5. All code instances were numbered to ensure traceability.
5	Are citations from the empirical data included without pointing to participants' identity?	Inclusion of citations from the empirical data are included as footnotes and linked with codes and code instances in §5.7.5.1 (illustrated by Table 5.12).
6	Was content validation done? A number of content validation techniques are available, including face validity, and the use of agreement coefficients. Options for seeking agreement may utilise a panel of experts, or dialogue among co-researchers.	Content validation was conducted through dialogue between the researcher and her study leader.

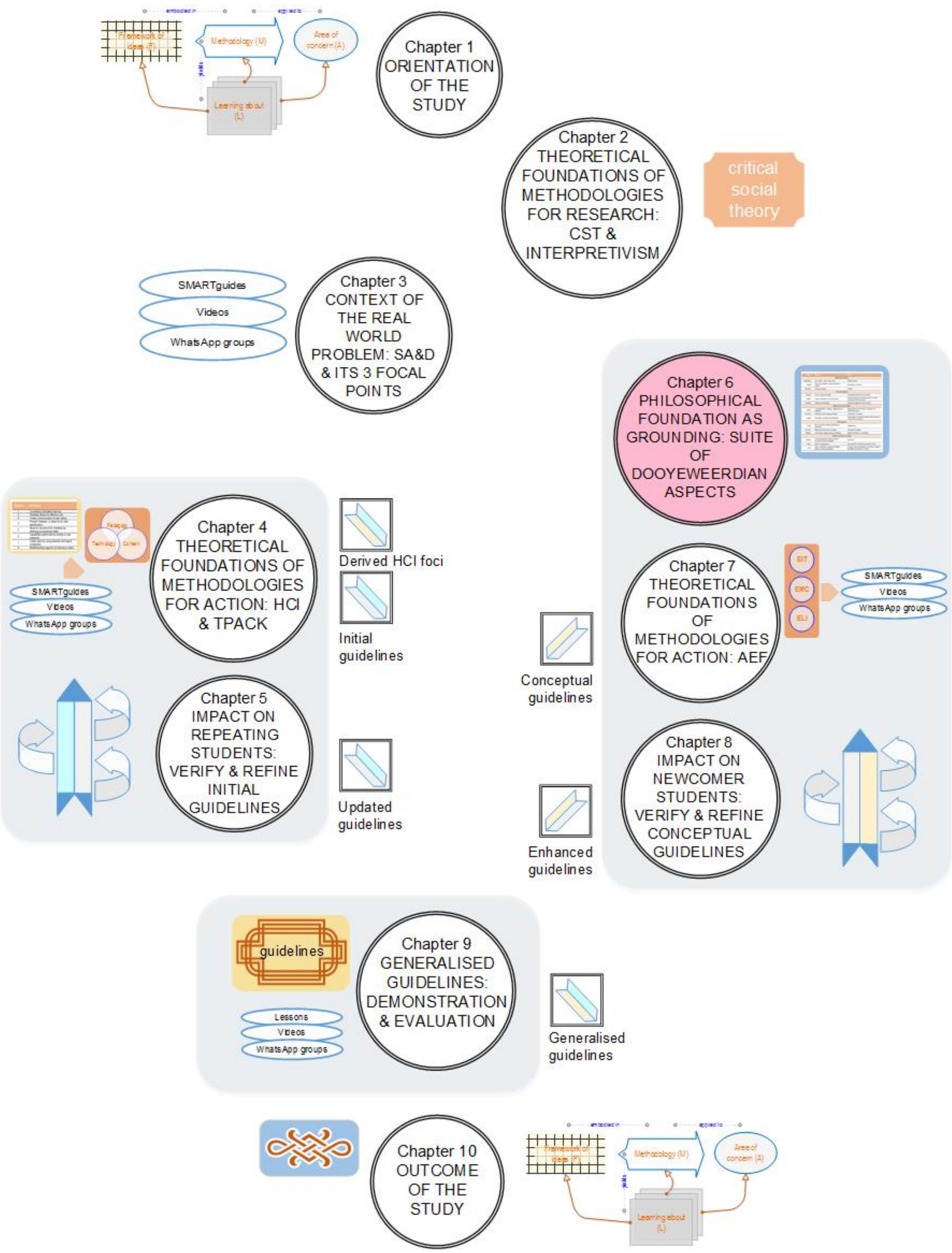
5.9 SUMMARY

The purpose of this chapter was to apply the method of AR to represent the evolution of the SA&D subject modules over a period of time. The first empirical objective (E01) were addressed in this chapter, namely to apply AR as five-step method to direct the verification and refinement of the initial guidelines that was extracted from the previous chapter. The focus was on the experience of students who repeated the first subject module and used the three focal points.

The five steps of AR were followed to guide this intervention. The intention was to emancipate repeating students to reach their full potential with the implementation of three focal points. Emancipation was guided by the verification and refinement of initil guidelines through the use of the derived HCI foci and the framework for TPACK interaction (Mishra & Koehler, 2006) to obtain updated initial guidelines.

The next chapter introduces philosophical perspectives pertaining to this research project by providing its philosophical framework, namely that of the 15 modal aspects developed by Herman Dooyeweerd. These aspects provide the philosophical grounding for the AEF developed by Basden.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



6 PHILOSOPHICAL FOUNDATION AS GROUNDING: SUITE OF DOOYEWEERDIAN ASPECTS

6.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education based on human computer interaction principles from a Dooyeweerdian perspective.

In order to achieve this primary objective, this chapter addresses the third theoretical objective (T03), namely to introduce the philosophy of Herman Dooyeweerd and investigate how his ideas, and specifically the 15 modal aspects that he developed, can be used to gain understanding on the use of technology to learn technological subject modules (Dooyeweerd, 1969).

In the subsequent sections, the following topics are discussed, namely the elements relevant to this study (§6.2), the philosophical framework utilised in this study (§6.3), the Dooyeweerdian philosophy in general (§6.4), and then with the focus is placed on the modal aspects developed by Dooyeweerd (§6.5). The last section concludes the chapter (§6.6).

6.2 ELEMENTS RELEVANT TO THIS STUDY

The model developed by Checkland and Holwell (1998b:23), and expanded to include the ideas of McKay and Marshall (2001), as well as that of Mathiassen *et al.* (2012) (see §2.6.2.3, and Figure 2.7), is shown in Figure 6.1 as applied to this chapter. It is used to draw a research plan for this study and aids in understanding the research process.

It is anticipated that F_I has little meaning on its own, and therefore, in the Mathiassen *et al.* (2012) suggestion, F translates to $F_{(A+I)}$, with the emphasis on A, and not so much on I, which leaves us with $F_{(\mathbf{A}+I)}$. Although it is anticipated that the Mathiassen *et al.* (2012) distinction is superficial, the $F_{(\mathbf{A}+I)}$-suggestion is used here to include when communicating contributions from this study.

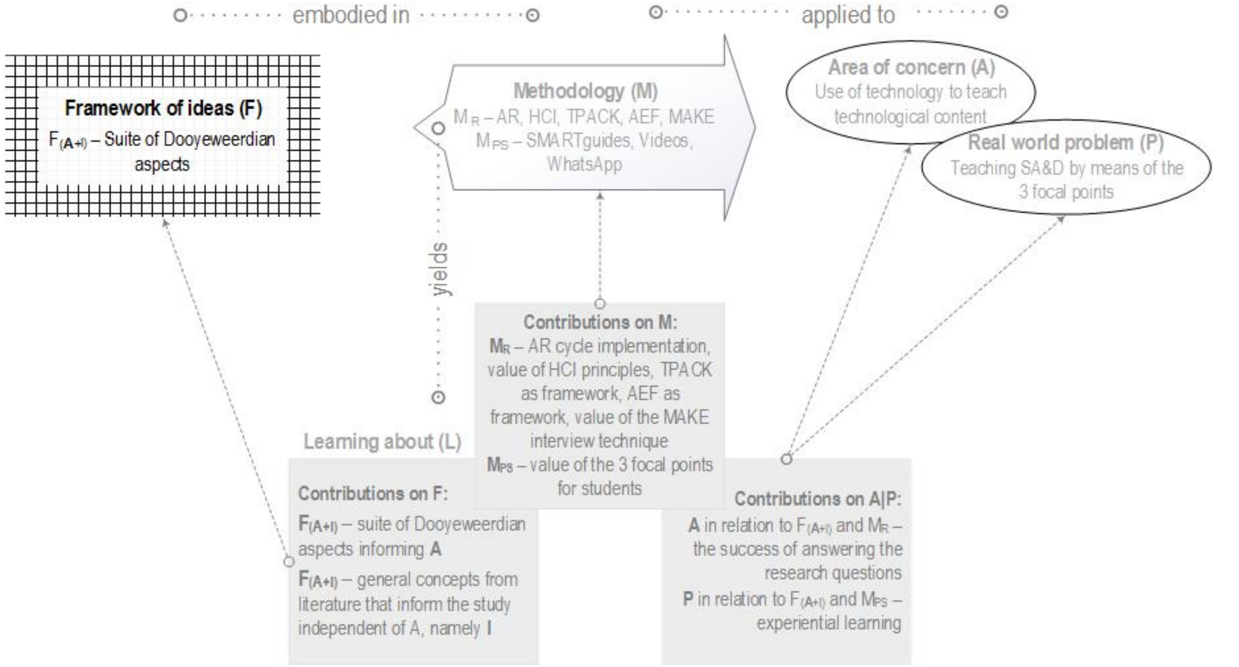


Figure 6.1: The elements relevant to this chapter

6.3 PHILOSOPHICAL FRAMEWORK

In this chapter, the study is grounded in philosophy and reference is made to three philosophical underpinnings, namely a general understanding of what philosophy is; what the relation is between philosophy, methodology and practice in addition to the FMA model discussed in the previous section (§6.1); and how methodology and practice may be guided and influenced by philosophy.

6.3.1 The nature of philosophy

Basden (2008:16) postulates that philosophy has many sides; it also serves many purposes, such as supplying us with "*frameworks of understanding*", it helps us to reason about matters critically, and logically clarify our thoughts. This is in agreement with Popma (1956:94) who defines philosophy as:

> *"To philosophise is to discern the structure of creation and to describe systematically, i.e. in logical order, what is subject to that structure."*

When Popma refers to "*structure of creation*" and what is subject to it, he refers to the whole of temporal reality, which includes animals, plants, minerals and people and their activities as represented by Dooyeweerd's 15 modal aspects of reality as discussed in Section 6.5.

Veenhof (1939:11), a Dutch theologian, who was in support of the development of a Christian philosophy, warned that we cannot be free from any philosophical taint; we are deceiving ourselves by believing that we start from facts and not presuppositions:

> *"... the less a scientist is conscious of ... inescapable attachment to certain presuppositions, the more is he chained to them and the more strongly is he dominated by them."*

In support of this warning, Kalsbeek (1975:8) argues that one cannot start with facts, because facts are not neutral; there is always a philosophical underpinning structure to facts.

Although the Dooyeweerdian philosophy may be referred to as a Christian one, its adoption does not require Christian commitments (Basden, 2008:47) and its intention is to facilitate mutual understanding between the Christian and the non-Christian (Brümmer, 2006:36). This notion is discussed in more detail in Section 6.4.3.

6.3.2 Philosophy in relation to methodology and practice

In the same way that research paradigms grounded in philosophy, guide methodology and an area of concern, the philosophy of Dooyeweerd may be used to guide the methodology and practice in a study in general. It is used in particular in this study. In this context it is wise to keep the reasons why philosophy is necessary when considering an area of application and its accompanying methodology supplied by Midgley (2000) in mind:

- justify valid practice in an area of application (Midgley, 2000:22),
- define which methodology to use in an area of application (Midgley, 2000:22),
- have implications for the construction of methodological guidelines obtained from philosophical arguments – which allows us to defend the guidelines in an area of application (Midgley, 2000:28),
- help us to guide our reasoning regarding methodological arguments which will allow us to justify notions that are intuitively felt (Midgley, 2000:29),
- help us to see practice in a different light, instead of restricting it in an area of application (Midgley, 2000:32), and
- allow us to critique methodologies, approaches and practices through philosophical analysis (Midgley, 2000:32).

Basden (2018:xii) brings philosophy in relation with real life:

> *"I pictured a line, with philosophy at one end, with 'real life' at the other, and scientific theories in the middle. But bend the line into a circle, and philosophy ends up next to real life—and that is where I see it now. Good philosophy is immensely practical, because it recognises the diversity of meaning in life."*

With the main objective of this chapter being to relate Dooyeweerd's philosophy to the three levels of organised use of rational thought, namely; framework, methodology and area of application to information systems (IS) from the perspective of its applicability to an understanding of human use of computers and specifically existing HCI principles in the context of education. In this study technology is used to teach and learn technology content, with HCI principles being an important consideration in this endeavour. Basden (2008:21), investigated some of the roles philosophy has in IS:

- We are looking for a philosophy *for* IS (and not *of* IS); we need philosophy to help us understand IS in an everyday way.
- It helps to create a conceptual framework on which one can build a theory.
- Research can be informed by epistemology; "*what constitutes good research?*".
- It allows us to employ insights of hermeneutics in order to develop an understanding of information technology (IT) in its broader context.
- We live with IS and we want to employ approaches of Existentialism to allow us to move away from Intellectualism that is presumed.

Therefore a philosophy enables people working in IS to make sense of it. In today's technological age, technology becomes part of our lives and all people are living with IS in an everyday way. Living with IS also infiltrated the way we teach and learn.

6.3.3 Midgley vs Fuenmayor

Midgley (2000:21) is of the opinion that philosophy (framework of ideas), methodology and practice (area of application) are areas of study that mutually supports one another. This view is contrasting with the view of Fuenmayor (1991), who believes in a strict hierarchy with philosophy being the foundation of methodology, methods which are based on the methodology, and practice the implementation of methods. Fuenmayor's view implies that methodology and an area of application depends on the chosen philosophy, with the philosophy taking precedence. This approach is not supported by giving absolute priority to the philosophical grounding being the most important aspect of how we think. When we study Figure 6.1 closely, "*the organised use of rational thought*" (Checkland & Holwell, 1998b), should allow a problem encountered in an area of application to inform an inadequacy in the philosophy. This notion is not conceivable from Fuenmayor's point of view, while it is supported by the view Midgley takes. Both viewpoints, that of Fuenmayor (1991), as well as that of Midgley (2000), is important in this study, as is explained subsequently.

6.3.4 Positioning of this study

The FMA model looks like it is hierarchically structured as suggested by Fuenmayor (1991), but in this study the view of Midgley (2000) which states that philosophy, methodology, and practice (F-M-A) is mutually supportive of one another, is followed. For the application of Dooyeweerd's modal aspects, the hierarchical viewpoint is valid, since Dooyeweerd's philosophy guides the study. Dooyeweerd's philosophy also has a secondary role in this study, namely supporting the validation principles for conducting critical social research as formulated by Myers and Klein (2011).

6.4 THE DOOYEWEERD PHILOSOPHY

The philosophy of Dooyeweerd is viewed from a general point of view, by looking at who Dooyeweerd was, which philosophers influenced his thinking and what his ground motives were.

6.4.1 The life and work of Dooyeweerd

Herman Dooyeweerd was born in Amsterdam on 7 October, 1894 where he grew up in a Calvinistic home (Henderson, 1994:15). He was influenced by the reformed protestant Abraham Kuyper (Kalsbeek, 1975:14). His academic career developed as follows:

- In 1912, he started studying law and concluded his academic law studies with the submission of his doctoral dissertation: "The Cabinet in Dutch Constitutional Law" in 1917 (Henderson, 1994:17).
- Between 1916 and 1926 Dooyeweerd occupied a variety of positions; initially he worked for the internal revenue service of Harlingen, a year later he became part of the municipal government of Leiden, the next year he worked for the Department of Labour in the national government in The Hague, drafting labour relations law, he

served as assistant director of the Abraham Kuyper Foundation, a research and policy organ of the Anti-Revolutionary Party of The Netherlands for five years. This last position allowed Dooyeweerd to engage in systematic reflection on the nature of Christian politics, where he also became involved in high-level political journalism (Kalsbeek, 1975:14).

- In 1926 he returned to academic life and became a professor in legal philosophy at the Free University of Amsterdam. His subject field included legal philosophy, encyclopaedia of law and medieval Dutch law. He retired from this position in 1964 (Basden, 2000).

Herman Dooyeweerd was the major founder of the philosophy of the cosmonomic Idea; a Christian philosophy that is biblically directed with a measure of philosophical insight contributing to making people consciously aware that we live in a spiritually divided and confused world and to assist us to direct our lives responsibly (Kalsbeek, 1975:7). Dooyeweerd passed away in 1977 (Henderson, 1994:13).

Being a Christian and coming from a background of politics and the law, Dooyeweerd felt that philosophy cannot be reduced to any one realm, for instance theology, politics, mathematics, or any other scientific field (Basden, 2008:26). To include all realms of life, Dooyeweerd (1984:6) compiled a number of transcendental conditions to make such a philosophy possible as translated and summarised by Henderson (1994:199). These conditions are summarised by Basden (2008:26):

- Everyday life should not be treated as a theory, but given due respect.
- Theoretical thought cannot be neutral – it is rooted in pre-theoretical thought.
- Philosophy should integrate the sciences and our experiences in everyday life – thought on relationships between these should be enabled.
- Philosophy should therefore be open to issues found in all disciplines.

Therefore the advantages of Dooyeweerd's suite is that it is focused on everyday life rather than having specific interests in mind, it is coherent, it covers more aspects with a wider reach than other suites, it takes multiple cultures and "*3,000 years of reflection*" into consideration, it is a philosophically grounded understanding of the nature of aspects (Basden, 2018:67).

6.4.2 Influences on Dooyeweerd thinking

From the start of Dooyeweerd's career in philosophy, he reflected on the thoughts of the great Greek thinkers, such as Aristotle (Kalsbeek, 1975:15). He was also influenced by prominent leaders of the early church, with Augustine being salient; those who shaped medieval Catholicism, such as Aquinas; and modern philosophers, Kant being most important (Kalsbeek, 1975:15). With Dooyeweerd's Philosophy embodying Christianity, Calvin's religious starting point is central; in addition, the influence of Groen van Prinsterer, as well as Kuyper on Dutch Protestantism is salient and they are therefore considered as spiritual ancestors of Dooyeweerd (Kalsbeek, 1975:16). Guillaume Groen van Prinsterer (1801-1876) was an aristocrat who came to Christian commitment which led him to devote his life to renew Christianity, mainly in Holland (Kalsbeek, 1975:16). Abraham Kuyper (1837-1920) was also a convert to Christianity, who was influenced by Groen van Prinsterer and became his successor in parliament (Kalsbeek, 1975:16).

6.4.3 A philosophy which provides common ground

At this point it may be helpful to take cognisance of a cautioning from Basden (2008:47) regarding Dooyeweerd, who:

> *"... sometimes referred to his philosophy as 'Christian philosophy'. This should not be misunderstood as being driven by Christian theology or ant-secular reaction, nor as requiring personal Christian commitment in those who adopt it."*

Brümmer (2006:36) also recognises this intention of the Dooyeweerdian philosophy to provide common ground between different religious schools of thought; Christian or non-Christian. He warns that the ultimate religious point of departure of Dooyeweerd's philosophy may fail to find a point of contact between philosophical views (Brümmer, 2006:43). This issue is discussed in more detail in Section 6.4.3.2. Having said that, Brümmer (2006:44) recognises that the Dooyeweerdian philosophy encourages discussion among Christians and non-Christians based on our common everyday experiences encapsulated in the suit of 15 modal aspects. This is discussed in depth in Section 6.5.

6.4.3.1 Ground motives

When investigating the nature of philosophical thinking (Kalsbeek, 1975:44), two important elements emerge. First, the religious antithesis or relative opposites manifests itself in various ground motives. Dooyeweerd (1979:7) defines antithesis as nothing more than "*opposition*". He goes further to explain that in the dialectical method of thinking, the antithesis concept may have a special meaning because as it bridges any contradictory concept. For example two logical opposites; that of motion-rest, where a higher connection is acknowledged between motion and rest which may be 'being', also in reality these two always appear together and the one cannot exist without the other. Therefore antithesis means "*the logical opposition of what belongs together in reality*" (Dooyeweerd, 1979:8). We encounter many antitheses in life; black and white, good and bad, and fun and boring. The second important element emerging from philosophical thinking is driven by these ground motives and does not follow a direction of its own accord.

Dooyeweerd (1984:58) defines a ground motive as the:

> "*moving power or spirit at the very roots of man, who so captured works it out with fear and trembling, and curiosity*"

Dooyeweerd (1979:9) perceives ground motives to be the most important driving forces of cultural and spiritual development of the West. He identifies four ground motives fundamental to Western thought: the Greek ground motive of *matter and form*; the ground motive which originated in the Christian religion that believed that *creation, fall, and redemption* occurs through Jesus Christ – in communion with the Holy Spirit; the *nature and grace* ground motive which originated in Roman Catholicism and attempt a combination of the first two ground motives; and lastly *nature and freedom* forms the modern humanistic ground motive and attempts to synthesise the three previous motives (Dooyeweerd, 1979:15). Throughout the development of philosophy, ground motives changed, but was consciously or unconsciously driven by religious ground motives and linked with its Archimedean point[6]. All philosophical thinking needs an Archimedean point, a fixed point of reference from which to proceed. This point may be from within

[6] "Metaphor derived from Archimedes' alleged saying that if he had a fulcrum and a lever long enough, he could move the earth. The Archimedean point is a point 'outside' from which a different, perhaps objective or 'true' picture of something is obtainable. It might be a view of time from outside time, a view of science from elsewhere, a view of spatial reality from nowhere. Philosophers of a sceptical or anti-realist bent, as well as deflationists and minimalists, often claim that such an alleged standpoint is merely fantastical, and the alleged objectivity of the view mythical." (Oxford, 2008)

philosophical thinking, called immanent, or outside the boundaries of philosophical thinking, called transcendent (Kalsbeek, 1975:56). Immanent and transcendental critique is discussed in Section 3.3.3.2.

The philosophical contribution of Dooyeweerd draws upon four ground motives. These are important motives of Western thought, three of them are, as explained above, dualistic in nature. One has its origin in the Bible:

- the Form-Matter ground motive,
- the Creation-Fall-Redemption ground motive,
- the Nature-Grace ground motive, and
- the Nature-Freedom ground motive.

Aristotle (384 BC-332 BC), a Greek philosopher, taught the *form-matter* ground motive which explained being, behaviour, and knowledge in terms of matter and its form (Basden, 2008:39). In today's world a thing such as a computer may be explained as metal, silicon and plastic (matter) which is manifested as a computer (form) (Basden, 2008:39); this differs from how Aristotle saw matter; as not determining the discreteness in people, animals, plants and stones – matter is the same for all of these, on the other hand form differentiates people, animals, plants and stones (Kalsbeek, 1975:63). The form-matter dualism idealised form, seen as good, while matter, on the other hand, is seen as evil and the aim is to live with as little matter as possible (Basden, 2008:39). Dooyeweerd (1979:16) explains that matter originated from nature religions where a "*formless, cyclical stream of life*" was deified with a golden thread being the worship of a tribe's ancestors. "*Mysterious powers*" influenced this stream of life, an unseen and immeasurable destiny called Anangke (Dooyeweerd, 1979:16). This "*life stream*" produced individual forms of men, animals and plants which aged and died, just to start a new cycle. "*Mother earth*" sustains all life. The focus is on the cycle and not the individual, who is doomed to disappear. Their view of time supports this notion – it being cyclical and not linear (Dooyeweerd, 1979:16). A newer religion developed from this matter motive, a religion of form, measure and harmony – representing culture being the form motive (Dooyeweerd, 1979:17). The Greeks' immortal gods could leave "*Mother earth*" and the "*cycle of life*" behind. Moira, in reality the Anangke of old, also played a significant part here. Initially Moira represented blind fate applicable to the "*cycle of life*", but later on the Moira imparted the meaning of 'share' or 'part' which implied some design instead of just blind fate. An example of Moira (meaning share) is where the three most significant Greek gods received a realm; the heavens (Zeus), the seas (Poseidon), and the underworld (Pluto) (Dooyeweerd, 1979:18).

Dooyeweerd insisted that the ground motive of *creation-fall-redemption*, should give rise to the Christian philosophy (Kalsbeek, 1975: 63). Here it should be emphasized that this ground motive underlying Christian philosophy is a fundamentally biblical given and not derived from theological reflection. Related to this argument, Popma (Boodt *et al.*, 1939:26) remarks that the Archimedean point is to be sharply distinguished from the *Arche* (Origin), which is God "*from whom, through whom and unto whom all things are*". This is an absolute antithesis of the form-matter ground motive (Dooyeweerd, 1979:28). The creation motive reveals God, the creator, as the sheer and perfect origin of things; He is the ultimate power and no contradiction regarding the creation (such as Anangke and Moira in the Greek tradition) stands (Dooyeweerd, 1979:29). The soul of man, also referred to as spirit or heart, is important in the discussion of the creation-fall-redemption ground motive; Dooyeweerd (1979:33) calls it "*the religious centre of human existence*" which recognises the immortality of individuals and stands apart from our physical body that is subjected to the cycle of life and death. Man has been created in the image of God, and although through sin man has created a rift between God and himself, through Christ's redemption, man is re-united with God (Dooyeweerd, 1979:35). The soul man transcends temporal life, which focus on aspects and functions categorised as 15 modal aspects by Dooyeweerd (1979:33).

Thomas Aquinas (1225-1274) formed a synthesis of Greek (form-matter) and Christian (creation-fall-redemption) thought (Basden, 2008:40); the *nature-grace* ground motive with this synthesis guiding mediaeval, scholastic thought and specifically Roman Catholic thinking over centuries (Kalsbeek, 1975: 63). Grace represents the sacred and nature the secular; this view separated nature from grace which allowed the church to become more and more powerful, allowing religious oppression (Basden, 2008:40). The Reformation and Renaissance started in reaction to this oppression; it also made a way for the emergence of the fourth ground motive, addressing a new age. Although this ground motive has a religious nature, it is in conflict with the creation-fall-redemption ground motive: God created man with the gift of grace to allow a relationship between man and God, and although man lost this gift at the fall in the Garden of Eden, human nature was not corrupted by sin, it was only weakened and therefore there is no need for redemption - grace can be restored by doing good works (Dooyeweerd, 1979:116).

The fourth ground motive is that of *nature-freedom* which exposed the huge severance between the Greek view of nature and the Christian religion, which presented a choice; the route of the nature motive could be pursued leading man away from the faith represented by the church, or a return to the creation-fall-redemption ground motive. The Reformation followed the latter route, while the Renaissance followed the first route – it rebirthed man in a truly natural sense where fate is in his own hands and not abdicated to any authority (Dooyeweerd, 1979:149). The humanistic religious motive is that of freedom where the human personality directs itself, relies upon itself, is self-sufficient, and do as (s)he wishes (Dooyeweerd, 1979:151). It represents enlightenment thought. Two religious motives, conflicting with one another is prevalent. Closely related to the nature motive is a motive of control and order which is connected to the freedom motive. This control motive aims to subject nature to man through the new method of mathematical science relying on the certainty of man's thought (Dooyeweerd, 1979:152).

6.4.3.2 Immanent and transcendental critique

Two philosophical concepts: namely *immanence*, meaning to remain inside (something) and *transcendence*, meaning to go beyond (something); with *something* being a boundary men have observed or even drawn are discussed here. When Dooyeweerd contrasts immanence with transcendence, he refers to another boundary; that of philosophical thought when he argues that philosophy as purely rational thinking is not possible – it is dependent on the philosopher's religious point of departure (Brümmer, 2006:35). He calls it a world view. Therefore Dooyeweerd refers to philosophies whose creators think they can stay within the boundary of philosophical thinking only and ignore religious influences as immanence philosophy (Kalsbeek, 1975:53). He believes that the starting point of philosophy is not immanent within philosophy, but transcends it. This idea links to the fact that philosophical thinking needs a fixed point, similar to the Archimedean point of reference on which to base its support (Kalsbeek, 1975:56). Where can we find this point of support? Will it be inside philosophical thinking (immanent) or outside its boundaries (transcendent)? Dooyeweerd argues that we need to look for the point of support in the sphere of religion. Juxtaposing this to the thought of Descartes (1596-1650) who said “Cogito, ergo sum” – I think, therefore, I am; thought being his immanent fixed point (Kalsbeek, 1975:57).

6.4.3.3 Philosophy of the Cosmonomic Idea

A philosopher attempts to systematically describe the structural order of the cosmos and its cohesion – which is common knowledge to every human being, although it may be in a naive way (Kalsbeek, 1975:67). Although this order of reality has not been proven, all philosophies progress from an idea of order. In Dooyeweerd’s philosophy, this order is interpreted as “*the law-side of temporal reality*” (Kalsbeek, 1975:68), which originates in the “*sovereign will of God*” (Brümmer, 2006:36). Dooyeweerd calls his philosophy the “*philosophy of the cosmonomic idea*” (“*de wijsbegeerte der wetsidee*”) (Dooyeweerd, 1936). Leibniz (1646-1716) developed the idea of pre-established harmony, referring to the harmony between material processes (in our body) and mental processes (in our mind). These two processes have no connection, it occurs in parallel, but in perfect harmony. This harmony is the law-idea of Leibniz’s philosophy. Dooyeweerd built on this law-idea and argued that some law order of the cosmos is the basis of every philosophical system independent of whether this is recognised by the philosopher (Kalsbeek, 1975:69). Dooyeweerd (1953:93) named his philosophy after the law-order because of his deep conviction to recognize this:

> “*From the start, I have introduced the Dutch term wetsidee (idea legis) for the transcendental ground-idea or basic Idea of philosophy. The best English term corresponding to it seems to be ‘cosmonomic Idea’, since the word ‘law’ used without further specification would evoke a specific juridical sense which, of course, cannot be meant here.*”

The law-idea of all philosophical thinking is formed by its Archimedean point, as well as the ground motive driving it. Dooyeweerd shaped the law-idea of his Archimedean point and the creation-fall-redemption ground motive as follows. God is our creator and the origin of our world, and He chose man as the crown of His creation. All structure in our Universe demonstrates modal aspects (quantitative to faith). Each of these aspects makes up an area of norms that is particular to it, called the law-sphere. Two sides exist to every modal aspect, namely the law-side as discussed, and a subject-side, which is factual (Kalsbeek, 1975:70).

Based on the law-side of Dooyeweerd's philosophy, the following guides us (Kalsbeek, 1975:70):

- the meaning of these laws is God's demand that man and all of creation, serve Him;
- the meaning of being subject is that man serve God lovingly; and
- the modal aspects are related in terms of "multi-sided coherence and irreducible distinctiveness".

Here Dooyeweerd does not intend something to *have* meaning, rather that something *is* meaning; and meaning and being coincides. Kalsbeek (1975:82) uses the example of a stork's nest to explain the difference; should one refer to a heap of branches as something that can be used by storks as a nest, it does not do justice to the role of the nest – it is not only used as a nest, it *is* a nest. The nest *is* the meaning.

It is worthy to mention that according to Dooyeweerd, the law is the boundary between God and His creation; God is above the law, while His creation is under the law (Kalsbeek, 1975: 73).

6.4.3.4 An extreme philosophy

According to Basden (2000), the philosophy of Dooyeweerd is an extreme philosophy. When one looks at the root of *extreme*, it does not mean "high degree", "severe" or "exaggerated", the Merriam-Webster Dictionary (Dictionary, 2006) indicates that the word stems from the Latin extremus, the superlative of exter, exterus – being on the outside. The meaning therefore stems from an attitude being on the outside; but outside what? Two important cultural assumptions regarding philosophy is identified by Basden (2000). The first assumption being that ordinary people may assume that philosophy is mostly abstract and its ideas have a limited practical application and no link with everyday life. Philosophy may even be seen as an alternative to religion. The second assumption suggests that people who know something of philosophy may think that philosophical thinking is neutral, it keeps asking questions, it is a universal tool, it should not be influenced by opinions, ethics or religion. Philosophy may even be superior to God. Basden (2000) places extreme philosophy outside accepted cultural assumptions such as the two mentioned above – which may compromise the true nature of something, so that it is true to itself and cannot be polluted or jeopardised. Extreme programming is a good analogy to use to explain extreme philosophy; it allows programmers to work on what matters, namely programming – most of the time, which allows them to produce the best programs (Beck, 2000:xvi), issues not pertaining to programming in itself, such as too many administrative tasks, are minimised. An extreme philosophy leaves us with a philosophy that focuses on what matters, the nature of philosophy itself – applicable to the everyday lives of ordinary people.

6.5 MODAL ASPECTS OF DOOYEWEERD

In relation to this study, an applicable part of Dooyeweerd's philosophy is his theory of modal aspects in which he developed 15 aspects of reality. Dooyeweerd (1969:4) argues that it is possible to describe all aspects of reality in terms of these 15 modalities.

In the context of this study, two authors who interpreted the work of Dooyeweerd are important, namely Leendert Kalsbeek and Andrew Basden. Leendert Kalsbeek (1903-1995) contributed by his introduction of the philosophy of the cosmonomic idea in layman's terms. He wrote this particular book "*for persons who desire to direct their life responsibly in conscious awareness of the spiritually divided and spiritually confused world in which we live*" (Kalsbeek, 1975:7). Andrew Basden's work in philosophies for IS contributes much – with one of the five areas of concern that interests him involving the human use of computers. He seeks to employ Dooyeweerd and his suite of aspects in the context of technology to create frameworks for understanding in five areas of IS by developing tools which are derived "*from philosophy but are orientated to everyday experiences of IT and IS"* (Basden, 2008:vi). Both of these gentlemen interpreted the 15 modal aspects, which make them more accessible in terms of understanding.

6.5.1 Fifteen modal aspects

In Chapter 1, Table 1.1, the 15 aspects are listed and each is illustrated with examples of types of things qualified by the aspect. Since it is difficult to remember the 15 modal aspects, Basden (2011) categorised the aspects in terms of its essence in functioning or the good it brings. The five categories, namely mathematical, pre-human, human as individual, social and structures of society are shown in Table 6.1. This grouping was not suggested by Dooyeweerd himself.

Table 6.1: The 15 modal aspects of reality identified by Dooyeweerd as categorised by Basden (2000); using the good it brings

Aspect	Meaning	Good
Mathematical aspects		
Quantitative	One, several, many; more or less	Reliable amount
Spatial	Here, there, between, around, inside and outside	Simultaneity, continuity
Kinematic	Flowing and going	Change
Pre-human aspects		
Physical	Forces, energy and matter	Irreversible persistence and causality
Organic	Living as organisms in an environment	Sustained being and functioning that is not wholly controlled by the environment
Sensitive	Feeling and responding	Interactive engagement with the world
Aspects of human individual		
Logical	Conceptualisation, clarifying, categorising and cogitating	Independence from the world; conceptual and theoretical thinking
Formative	Deliberate creative shaping of things	Achievement, innovation
Lingual	Expressing, recording and interpreting	Externalisation of intended meaning; referring beyond to whole web of meaning
Social aspects		
Social	We, us and them; relating, agreeing and appointing	Togetherness
Economic	Managing limited resources frugally	Sustainable prosperity
Aesthetic	Harmonising, enjoying, playing, beautifying	Delight that seems non-necessary
Aspects of structure of society		
Juridical	Due appropriateness, debt and reward, structures of policy and legality	Due for all
Ethical	Attitude, self-giving love	Extra goodness, beyond the imperative of due
Pistic	Vision, commitment, certainty and belief; aspiring, trusting, worshipping	Courage, hope and openness to the Divine; change in the attitude and direction of society

The 15 modal aspects are discussed below. The explanation of each modal aspect is introduced by stating the kernel meaning Dooyeweerd himself attached to an aspect. This is followed by the explanation of each by Kalsbeek and Basden. Kalsbeek selectively explained the aspects. The intuitive interpretation Basden gives of each aspect allows a broader understanding. In some cases Basden's interpretation of what an aspect is NOT, is also indicated. When other sources such as Bergvall-Kåreborn cast light on a particular aspect, that source is used to bring a deeper understanding to the explanation.

Upon the formal discussion of each modal aspect, the understanding and experience of each modality in the mind of the researcher is illustrated in the context of teaching systems analysis and design (SA&D) with the focus on technology as vehicle and HCI principles guiding its implementation. This understanding and experience is supported by the HCI principle summary as discussed in Chapter 7. Bergvall-Kåreborn (2002:28), who relates her understanding of systems design, as well as the interpretations of Basden (2008:129, 183) on the usage of an artefact (Elsie) and the functioning of a computer was helpful in the guiding of understanding.

In the philosophy of the cosmonomic idea, the 15 modal aspects are not placed in a particular order and in the Dooyeweerd (1969:61) discussion, no "*systematic arrangement*" is attempted. Kalsbeek (1975:96) makes us aware that modal aspects are recognized as earlier or later, where the earlier aspects form a foundation for later aspects. Here we would call a foundational aspect a "*substratum sphere*" and an aspect based on another a "*superstratum sphere*". The order used for the discussion is based on starting with the quantitative aspect which have no foundational aspect and ending with the pistic aspect which have no aspect building on it.

Table 1.1 in Chapter 1 uses the modal aspect naming of Dooyeweerd. In Table 6.1 the naming of Basden is used, except for the last aspect (pistic), where the researcher holds that the connotation of "trust" with pistic represents a broader meaning compared to "faith" and is therefore more applicable to the study. In the discussion below, both terms are listed – on the occasion that more than one exists – where the ones listed first are used in the rest of the study.

6.5.1.1 Quantitative / Arithmetic aspect

Dooyeweerd (1969:62, 79) describes the quantitative aspect's kernel to be a discrete amount representing a quantity, something that is countable and having mathematical significance. This first aspect has no substratum and is referred to as a terminal sphere (Kalsbeek, 1975:96). Basden (2000) refers to the quantitative aspect as 'numberness' as opposed to 'numbers' where the quantitative aspect is absolutely reliable in the sense that fiveness will always be fiveness, it cannot be sixness; something that is always so no matter where you are or in which time you live (Basden, 2008:290). Basden (2000) intuitively states it to be one, several, many, more or less. Another way to understand it, is to look at what the quantitative aspect is not; it is not a continuous number which

Dooyeweerd classifies as spatial; also it is not a number expressed as digits, which is lingual; and it also is not distinguishing the items that we count as we would do in set theory to see each thing as a meaningful individual, which is analytical (Basden, 2000). Bergvall-Kåreborn (2002:24) makes us aware that terms including ‘number’ and ‘quantity’ are originated in the arithmetical sphere because of the fact that they can be used without an adjective qualifying them. Whenever a term such as ‘unity’ needs an accompanying adjective such as ‘logical unity’ or ‘social unity’ it gives an indication that the term is used outside the quantitative sphere. This may be used as a rule of thumb (Bergvall-Kåreborn, 2002:24) to determine aspectual belonging of a term:

> “*one criterion for determining to which aspect a kernel or term belongs is that it can be used within the specific aspect without a special qualifying adjective denoting its general modal sense*”.

According to Bergvall-Kåreborn (2002:28), the quantitative modality is essential in the use of technology, with the basis of IS being numeric – it is therefore treated as important in the teaching of the SA&D subject modules.

6.5.1.2 Spatial aspect

Dooyeweerd (1969:102) identifies the spatial aspect’s kernel to be a continuous extension representing lines, areas and volumes, something that spreads out in a continuous way. Kalsbeek (1975:100) makes us aware that meaning of aspects relates to ‘how’, not something concrete; therefore continuous extension as indicated by Dooyeweerd does not represent the space we see, which is concrete. Basden (2000) refers to the spatial aspect as having simultaneity because its parts are all simultaneously present and he intuitively states it to mean here, there, between, around, inside or outside. It is not a shape, which is formative, it does not occupy space, which is physical and it is not x and y coordinates, which would be classified as quantitative (Basden, 2000). Bergvall-Kåreborn (2002:24) stresses the fact that this aspect has the arithmetical aspect as its base, but space is having two, three or more dimensions. She continues to explain that the word ‘spatial’ (representing how) is preferred as the aspectual descriptor instead of ‘space’ (representing what) since the latter may evoke the idea that space have substance. Bergvall-Kåreborn (2002:28) identifies issues that is limiting or enhancing the physical, mental or social space to be important when it comes to IS.

6.5.1.3 Kinematic aspect

Dooyeweerd (1969:98) describes the kernel of the kinematic aspect to be a mathematical movement. Initially Dooyeweerd did not classify the kinematic as an aspect, but later derived it from the spatial and physical because he experienced paradoxes (Kalsbeek, 1975:101). Basden (2000) intuitively states the kinematic to be introducing change, it represents flow and movement (Basden, 2008:64). Animation is a good example of the kinematic (Basden, 2008:155), where computer "*animation might be closer to the kernel of the kinematic aspect than movement of matter since animation involves no matter as such*" (Basden, 2000). It is not speed, which is a quantitative representation of movement, it is not represented by changes in speed and it is not just changes in spatial position. It is also not inertia, which is rather of the physical aspect (Basden, 2000), but it is related to the principle of inertia and how Galileo defines uniform motion (Bergvall-Kåreborn, 2002:25).

6.5.1.4 Physical aspect

According to Dooyeweerd (1969:99) the kernel of the physical aspect is energy. Basden (2000) intuitively describes it to be forces, energy and matter. Although one would often talk about something as physical, when we view reality from a physical point of view, there are no separate things since there are no boundaries in physics. Basden (2000) gives examples from a quantum and macro level of 'stuff' rather than 'things' because of a lack of boundaries:

- Quantum level: the wave equation runs into infinity.
- Macro level: physical laws cannot give us an indication of where one mountain ends and the next one begins.

Supposed things may be classified as sensitive or analytical since they can only be classified as *things* when we experience them through our senses or analytic reasoning (Basden, 2000). Bergvall-Kåreborn (2002:25) posits that this aspect is closely related to kinematic aspect since cause and effect is implied by energy and the basis of movement is cause and effect.

6.5.1.5 Organic / Biotic aspect

Life and life functions are identified as the biotic aspect's kernel by Dooyeweerd (1969:107). (Basden, 2000) refers to the biotic aspect as generation, such as in a life-cycle. He intuitively states it to be 'thingness' or living organisms in the environment. It is not biology as such. In communication between Basden and Magnus Verbrugge, Verbrugge explained the link between the biotic aspect and the earlier aspects (Basden, 2000):

> *“Each material thing shows that it functions in the four earlier aspects: it is one entity or functor but may have a number of parts and will show a number of functions, its numerical aspect. It takes up space, showing its spatial aspect. It shows motion in its internal organization and also in relation to other entities. And it shows physical functions such as gravity, magnetism, etc. Physical things may be atoms, molecules etc.”*

Bergvall-Kåreborn (2002:25) agrees with Kalsbeek (1975:100) that the kernel of the biotic modality should rather be vitality since life is mostly taken to be something concrete.

6.5.1.6 Sensitive / Psychic aspect

Dooyeweerd (1969:111) identifies the sensitive aspect’s kernel to be feeling. Although psychology often divides experiences into three classes which includes willing, knowing, and feeling; the former two function in all aspects, while the latter quality belongs to everyday experience and is irreducible (Kalsbeek, 1975:101). Basden (2000) refers to the sensitive aspect as including sensory ability, emotion and imagination. Bergvall-Kåreborn (2002:25) agrees with Basden and adds a sensory perception to feeling as the kernel meaning of the aspect, where feeling through the senses is a reaction to biological stimuli although it cannot be explained biologically.

6.5.1.7 Logical / Analytical aspect

Dooyeweerd (1969:118) identifies the analytical aspect’s kernel to be making distinctions with this aspect strongly relating to the quantitative aspect, he explains (Dooyeweerd, 1969:80):

> “*Every analytical relation, ... implies a numerical analogy, because analysis itself is a manner of distinction, and distinction implies at least two terms: the one and the other.*”

Basden (2000) refers to the analytical aspect as distinguishing one thing from the other. He intuitively states it to be conceptualising, clarifying and reflecting. It is not discreteness, which would be classified as quantitative. Bergvall-Kåreborn (2002:25) highlights the fact that analytical distinction is based on two concepts, namely identity and contradiction.

6.5.1.8 Formative aspect

Dooyeweerd (1969:121) used synonyms such as *cultural* and *historical* and identifies the formative aspect's kernel to be formative power because of his stance that history is not created, but formed. This formation of history should be extended to include ordinary people living daily life through which "*ordinary utensils*" were allowed to be developed, instead of only focussing on prominent historic people (Kalsbeek, 1975:99). Basden (2000) refers to the formative aspect as being innovative. He intuitively states it to shape things in a deliberate and creative way and he places technology within its scope. The formative aspect is not including the assembly of a spider web or a kit, it excludes automated production, it also does not include the flow of time through history. Bergvall-Kåreborn (2002:26) explains the kind of formation implied here as:

> "*a cultural mode of formation, represented by a human being(s) who moulds a given situation into something new, something that would not have come about all by itself.*"

This modality deals with the present, as well as the past; what we do today becomes tomorrow's history (Bergvall-Kåreborn, 2002:29). We do what we can with what we have at our disposal, and thus have an influence on the future.

6.5.1.9 Lingual aspect

Dooyeweerd (1969:126) identifies the lingual aspect's kernel to be symbolic signification. Basden (2000) refers to the lingual aspect as the externalisation of the meaning we intend. He intuitively states it to be our expression, recording and interpretation of meaning. It includes text, pictures, videos, animations and gestures. Interesting enough, body language is not lingual, as it is not deliberate. Bergvall-Kåreborn (2002:26) is in agreement with Kalsbeek (1975:101) when she categorises all the languages in the world, as well as sign language and symbols such as flags as lingual.

6.5.1.10 Social aspect

Dooyeweerd (1969:135) identifies the social aspect's kernel to be intercourse, meaning dealings between individuals or groups. Basden (2000) refers to the social aspect as keeping company, having social interaction, friendship and mutual respect. He intuitively states it to be we, us and them – being together. It is not dividing people into classes or gatherings. Bergvall-Kåreborn (2002:26) highlights the relation between being subjective and having authority – to understand relationships; and the relation between groups and individuals.

6.5.1.11 Economic aspect

Dooyeweerd (1969:127) identifies the economic aspect's kernel to be frugality. Basden (2000) refers to the economic aspect as sustainable prosperity. He intuitively describes it to be thrifty in managing limited resources. It is not finance – classified as quantitative, also not the worth of something, which is symbolic, while production, distribution and consumption has to do with the formative aspect. Bergvall-Kåreborn (2002:26) reminds us that we require planning and balance in the distribution of our means, and therefore "*wasteful satisfaction of a particular need at the expense of other more urgent needs is considered uneconomic*".

6.5.1.12 Aesthetic aspect

Dooyeweerd (1969:135) identifies the aesthetic aspect's kernel to be harmony. Basden (2000) refers to the aesthetic aspect as the introduction of delight, possibly not necessary, and excellence. He intuitively states it to be (en)joy(ment), play(fullness), harmony. It is not creativity, which would be classified as formative. According to Bergvall-Kåreborn (2002:27) this modality includes beauty and art that is normally associated with the aesthetic, but also man-made artefacts and the beauty we find in nature; she relates this aspect to four others:

- the economic aspect safeguards us against excessiveness;
- the social aspect highlights the association between the aesthetic and fashion;
- the formative aspect points to the fact that artists are also guiding style; and
- the lingual aspect conveys the symbolic significance of harmony.

Although Bergvall-Kåreborn (2002:30) deems this aspect not be of much importance to designers of systems, it is of importance in the design of devices such as mobile phones and computers. Her point of view may be debated since the representation of an application may be aesthetically pleasing or displeasing.

6.5.1.13 Juridical aspect

Dooyeweerd (1969:129) identifies the juridical aspect's kernel to be retribution. Kalsbeek (1975:102) find the word "*retribution*" to be striking "*the ear with a rather unpleasant ring*". Basden (2000) refers to the juridical aspect as what is due for all. He intuitively states it as legal and political structures, that what is due, namely restitution. It is not law and order as such or judging, which is analytical. Legal systems are the mechanisms man has formed to fulfil what we understand as its kernel. Bergvall-Kåreborn (2002:27) suggests the kernel of this aspect to be justice. Dooyeweerd (1969:129) explains:

> "*This mode implies a standard of proportionality regulating the legal interpretation of social facts and their factual social consequences in order to maintain the juridical balance by a just reaction, viz. the so-called legal consequences of the fact related to a juridical ground*".

6.5.1.14 Ethical / Attitudinal aspect

Dooyeweerd (1969:144) identifies the ethical aspect's kernel to be love – a misleading word. Kalsbeek (1975:102) calls it "*humanitarian love for one's neighbour*". Basden (2000) refers to the ethical aspect as giving more than is due. He intuitively states it to be self-giving love (the Greek agape), which involves generosity, sacrifice and goodness. It is not what one ought to do or keeping moral rules, it is not self-centred love, it is also not friendship or being nice to people. Bergvall-Kåreborn (2002:27) links the ethical to the juridical in that one should be kind when judging other people.

6.5.1.15 Pistic / Faith aspect

Dooyeweerd (1969:133) identifies the pistic aspect's kernel to be faith. It is true that faith does not include the Christian faith at the exclusion of other faiths (Kalsbeek, 1975:102). Basden (2000) refers to the pistic aspect as openness to the Divine. He intuitively states it to be vision of myself, belief in God, certainty about my belief and commitment to God, trust and worship. It is not creeds, which are lingual expressions of what we believe; it is also not rituals – classified as both aesthetic and lingual expressions. Bergvall-Kåreborn (2002:28) accentuates the fact that *pistic* is the Greek word for faith. She also creates awareness of the fact that faith means different things to different people.

6.5.2 The 15 modal aspects applied to this study

The Dooyeweerdian suite of 15 modal aspects that was discussed in Section 6.5.1, is related to this study in Table 6.2 – in order to place it in the context of this study and also to list material to be used later in the study when aspectual analysis should be done.

Table 6.2: The Dooyeweerdian suite of 15 modal aspects applied to this study

Modal aspect	Applied to this study
Quantitative	Examples of important issues in this context, include the (number of) students in the class, the assistants supporting student learning, the pages to be read in the SMARTguide, the participants and messages sent in the WhatsApp group, the videos available to teach challenging concepts, the pages of the text book, the questions (asked by both the students and the lecturer), the potential answers to a question, cost of participation (time to do the subject modules and money to enrol, money to buy technology and that allow access to the SMARTguide and peers when off-campus), and the number of HCI principles guiding the use of technology. When it comes to group work, an indirect teaching and learning tool in the context of the subject modules, the number of group members are important, the allocation of roles in each group (for example, the number of programmers may have an influence on the quality of the project). On a technical level the number of tables forming part of the database implemented, the number of functionalities implemented, and the number of system applications (in addition to a basic system, a web-application and/or a mobile app may be useful in the application environment) are important in the allocation of marks.
Spatial	In the case of teaching a technology subject module, it is important to consider the physical space you are in when attending theory and practical classes; the size of the classes and diagrams to be drawn when explaining concepts in the subject modules are included here. Virtual spaces are important when considering the use of the SMARTguide, watching videos, and using WhatsApp to support learning progress and improve competence. These virtual spaces and the impact they may have on a student's learning are guided by HCI principles. The mental space of the lecturer when teaching, and the mental space of the students when learning, may be a point of discussion. With great emphasis placed on group work in teaching and learning, social spaces are significant when teaching and learning SA&D. Physical spaces are important for the project development of groups as well, since they need a place to work, individually and in groups. On a technical level students need to address the memory space their project's populated database will use, as well as the consideration of system boundaries.
Kinematic	Movement while teaching – which manifests in acting roles or role playing, and learning the material by writing notes, typing assignments or system's documentation, reading the SMARTguide or textbook. The application of HCI principles is important in directing the flow of virtual matter which manifests in the SMARTguide, videos and the WhatsApp groups. Role playing may also be required when students are asked to use video-making to represent a concept. Animation is a point of discussion in the SA&D class, since it is used in the self-assessment section of the SMARTguide. It is also required of students when using web-tools to represent content, such as GoAnimate. Work done on the project would require the flow of data and relationships between tables.
Physical	The capacity of the technology available for teaching (those available to lecturers when teaching theoretical and practical classes, and students when doing practical work in class) are important. Also, the provision of energy, or lack thereof, influences the continuation of access to computers to work, since interruptions prolongs the time needed to complete a task. Physical energy which is obtained by eating good food that sustains one during a day is important, especially for students who may not have the means to sustain themselves. In the South-African context, the interruption in electricity supply due to an over-demand which is occurring regularly and without warning is a point of contention.
Organic	When looking at the physical aspect, one needs to consider the fact that all students do not hear the lecturer, and do not see the material in the same way. As an example a practical class can be envisioned where Facebook, YouTube and many other distractions are accessible – while the lecturer is busy teaching. Students with funding constraints may not eat well, which influence their ability to learn, while others may be unwell in a biological sense. Two sides of interruptions may be considered here; on the one hand interruptions hinder study progress, but on the other hand it may motivate a much needed break from learning. The application of HCI principles to an educational system such as a SMARTguide, may provide it with a vitality, which may ensure that students would prefer to use it to learn. In their project work, the physical aspect will guide students' design of the system and especially the user interface.

Modal aspect	Applied to this study
Sensitive	The sensitive modality may be helpful in initiating feedback regarding how students feel about SA&D as subject modules and how it is taught. For instance; are students feeling good about learning the concepts and improving their skills? These feelings may be extended to the use of the SMARTguide, watching of videos, and the use of WhatsApp and is guided by the HCI principles. In the case of the use of WhatsApp, the debate regarding the use of smartphones to support learning may be interesting. In the development of their project system students should be made aware of their users' feelings regarding the use of the system they design and build; the use of the IS may be easy or difficult, they may trust that the system will work well, or this trust may be absent.
Logical	In this study, the analytical aspect is qualifying in both SA&D and its teaching and learning. When teaching and learning SA&D, it is important to be able to make distinctions; manifesting in finding correct answers to questions to allow progress, and supplying correct answers to questions in assessments. It is important to stimulate debate on the role of the SMARTguide, videos on challenging concepts, and support found on the WhatsApp group when preparing for assessments in facilitating learning. The HCI principles have logical applicability in the realm of guiding the compilation of such technological tools. In the analysis, design and development of an IS in the group project distinguishing between the roles of stakeholders, data-information-knowledge, levels of access to data and functionality, and different flows such as that of data or logic.
Formative	In the same way the teaching of the subject modules in past years influences future classes; structuring of sentences and diagrams and how particular concepts are taught, are examples. In the same way the SMARTguide is adjusted – based on the lecturer's reflection, inputs from colleagues and students' feedback. The same happens with regard to videos on challenging concepts, while the use of WhatsApp to guide students in their preparation for assessments is the result of the progress experienced over the past years with regards to smartphones and the applications facilitating instant messaging. In itself, the WhatsApp application evolved to include more members and more features which allows changes in how it is applied in the educational context. In the same way HCI principles may evolve to stay applicable to the current state of technology. When students develop systems, it is important to look at what is already in existence with regard to that particular application to be able to build on existing knowledge.
Lingual	Since communication is important in SA&D, as well as in its teaching and learning where some form of symbols would be used, the lingual aspect is qualifying. Examples of symbols used when teaching and learning include material such as the textbook (language, pictorial representations and models), the SMARTguide, videos, and communication on a WhatsApp group. The message that is communicated through multiple electronic means is guided by HCI principles to ensure effective communication. The systems built in the project groups uses documentation tools to explain concepts through language, modelling, and eventually the system is coded in a computer language; this manifests as a system with access control, a user interface, and functionality.
Social	Teaching and learning of SA&D, as well as the SA&D profession is a social activity that entails social relationships which involves roles, norms, and power relations (Bergvall-Kåreborn, 2002:29). In the case environments, the WhatsApp group also have an interactive social structure. Discussion regarding lecturer and student roles and how they might change, as well as how power may be gained or lost may facilitate understanding. The proper application of HCI principles to electronic means may make these tools more accessible to students. This is especially prevalent in the context of the project groups where students accept roles to fulfil. These roles may change during the year's progress, possibly because of regroupings or other factors.
Economic	Completing higher education subject modules have a huge economic impact on students. Likewise, building a system uses economic arguments as justification. When moving the focus to the frugal use of available resources; resources such as computers, freeware, software and memory may be utilised in teaching and learning, as well as when building a system. In both instances already acquired knowledge, skills, and competencies are valuable for the purpose of scaffolding new knowledge, skills, and competencies. It is true that since many students are making use of the resources, careful planning and making use of resources in a balanced way is crucial. In the implementation of a system, the same principles should be adhered to; the database should use memory frugally, and the system as well – this ensures a resource-sensitive system with quick reaction times. Applying HCI principles to applications supports frugality.

Modal aspect	Applied to this study
Aesthetic	The HCI principles guide this experience. A seamless experience is dependent on how functions are grouped together, and how an item relates to and harmonises with another. In a SA&D context, harmony is anticipated between teaching, classes and tools – including the SMARTguide, videos, and WhatsApp group. In WhatsApp a group with a large number of members may produce more than one communication line which may confuse members. With the implementation of a new feature a member may refer to an earlier post to ensure that an answer is placed in context. When a group's project system is evaluated; a system and its subsystems should harmonise with one another. This would include the user interface(s) and how functionality is enabled.
Juridical	Both the teaching and learning of SA&D and the development of systems are time-intensive and costly. Juridical understandings are put in place to guide the processes and ensure the delivery of 'what is due'. In the teaching of SA&D actual student learning needs, as required by the IS industry, may be addressed by a number of interventions, of which the SMARTguide, videos, and the WhatsApp groups would be examples. After each intervention, content is assessed to ensure that learning takes place. The application of HCI principles may influence how effective learning is, as well as the joy of the learning experience. In the development of their projects students need to deliver an artefact according to the needs of users; this include the user interface, the scope of the system, and its functionality. Although cost and time are constraints, it does not manifest in the same way as it would in the real world. In an educational environment, these considerations are simulated by making use of a rubric to ensure that an agreement is fulfilled.
Ethical	When relating the ethical aspect to the juridical, the ethical asks more than is due. In some instances technology may facilitate this notion; a student may watch a video multiple times, and stop and start it at will without taking up the time of the lecturer. The careful application of HCI principles may facilitate this extension of the lecturer. When it comes to assessment, or the evaluation of students, the introduction of more than one assessment opportunity may allow students to learn in the process of making mistakes and correcting them. In both the situations of teaching and learning SA&D; as well as the development of a group project system, one would produce more than what is expected; not because one has to, or because one gets paid for doing it, or because one earns marks for it.
Pistic	In both SA&D, and its teaching and learning, change is involved. The pistic aspect encapsulates our attitude towards this change (Bergvall-Kåreborn, 2002:31). Although a shared goal among educators and the IS industry is to ensure the acquiring of knowledge and skills required by the IS industry, for some people IS may be the answer to all problems, while for others it is a threat to society (Bergvall-Kåreborn, 2002:31). The researcher agrees with Bergvall-Kåreborn (2002:31) that the pistic modality is different from the other aspects, belonging to a higher level – in the sense that what we believe in influences how we view the other modalities. Breems (2014:43) places this aspect in the context of this study; implementation of artefacts should be done as reliable as is possible. The HCI principles may aid the latter two views since its proper or improper application may influence how students perceive technology and how well they learn.

With the modal aspects contextualised, the characteristics of the modalities are investigated.

6.5.3 Characteristics of the fifteen modal aspects

The rest of this section aims to provide a deeper understanding of Dooyeweerd's philosophy by addressing the value and characteristics of the modal aspects. From the explanation of the 15 modal aspects, it is clear that every aspect has a particular role in life and should we omit one or more, things will not be functioning optimally any more, if they will function at all. Each and every modal aspect has a kernel of meaning which provides us with a specific way in which life makes sense to us. Basden (2000) refers to aspects as "spheres of meaning". It allows us to be, and for us to be, and to be has meaning. It is true that things mostly have several (aspectual) meanings; using the cellular phone example; a cellular phone addresses our need to communicate (lingual aspect), it is a created artefact (formative aspect), it is used to interact socially (social aspect) and we may use it to access interesting information and play games that are fun (aesthetic aspect). The modal aspects also allow *levels of description*; a distinct set of *concepts* are associated with each aspect that one can use to discuss things, and a thing may be described in any of the aspects in which it carries meaning – mostly in a number of aspects, or multi-aspectually. No one aspect can be discounted and in the same way none may be idealised. Therefore, each one is as important as the other. One cannot explain one modal aspect in terms of another one – aspects are irreducible to one another. Aspects have a linear order from quantitative to faith with two fundamentally different directions of dependency, namely anticipatory (reaching towards later aspects) and retrocipatory (reaching towards earlier aspects) which relates them by analogy.

Another important part of Dooyeweerdian thinking is the theory of individuality structures. It is important to note here that we must be careful not to confuse individuality structures with aspects, they are not synonymous terms. Kalsbeek (1975:42-43) explains individuality structures:

> *"... is a concrete, whole entity or event which has special qualities distinguishing it from all other individuality structures."*

When we work with individuality structures we always ask the question: *what?*, while with aspects the question is: *how?*, since it concerns itself with the *manner* of being – a **mode**, that is why Dooyeweerd refers to them as modal aspects. Therefore; when an individuality structure is analysed theoretically, it is crucial to start with the modal aspects, only then can the investigator understand the entity as a whole. In this research project one's *what*-experience involves the lecturer and some of the students using a mobile instant messaging application (MIMA) on their smartphones to allow them to discuss their progress, and ask questions in preparing for assessments. When one asks *how* this is experienced, the 15 modal aspects, are involved.

According to Dooyeweerd (Basden, 2008:80), a theory of "*thingness*" – to understand an entity as a whole, should account for our everyday experience of things. He believed that things are not only what we experience through our senses, things engage with us and we engage with things. When we refer to meaning we say something *has* meaning, we will never say something *is* meaning; yet the latter is exactly what Dooyeweerd is saying. According to him, meaning and being collide. If we use the cellular phone as an example; should we call it some plastic with electronics in it, we do not do it justice; it is a cellular phone because it was built as such. It is not a cellular phone because we *attach* this meaning to it, it being a cellular phone *is* its meaning. This is true for everything in temporal reality, and it is true with the individuality structures, which presupposes one another (Kalsbeek, 1975: 80, 82).

The aspects of special interest in this study would include the lingual, social and juridical aspects. Each aspect has a kernel of meaning along with retrocipation and anticipation of other aspects through which, each aspect inherently relates to others (Basden, 2008: 70). Therefore it is import to realise that the structures of modal aspects may be dependent on one another, for example a cellular phone is used mainly for communication (lingual aspect), but it is used in a particular cultural environment (formative aspect) and is embedded in a particular technology (formative aspect) – retrocipation; and a cellular phone is a tool to socially interact (social aspect), but that interaction creates interest and fun (aesthetic aspect) for the user – anticipation.

The discussion of the modal aspects as suggested by Dooyeweerd is concluded. Although some Dooyeweerdian concepts such as structure, normativity and the Shalom principle have not been discussed here, they are addressed in the next chapter where the human use of computers framework for understanding which relies on their understanding, is discussed.

6.6 SUMMARY

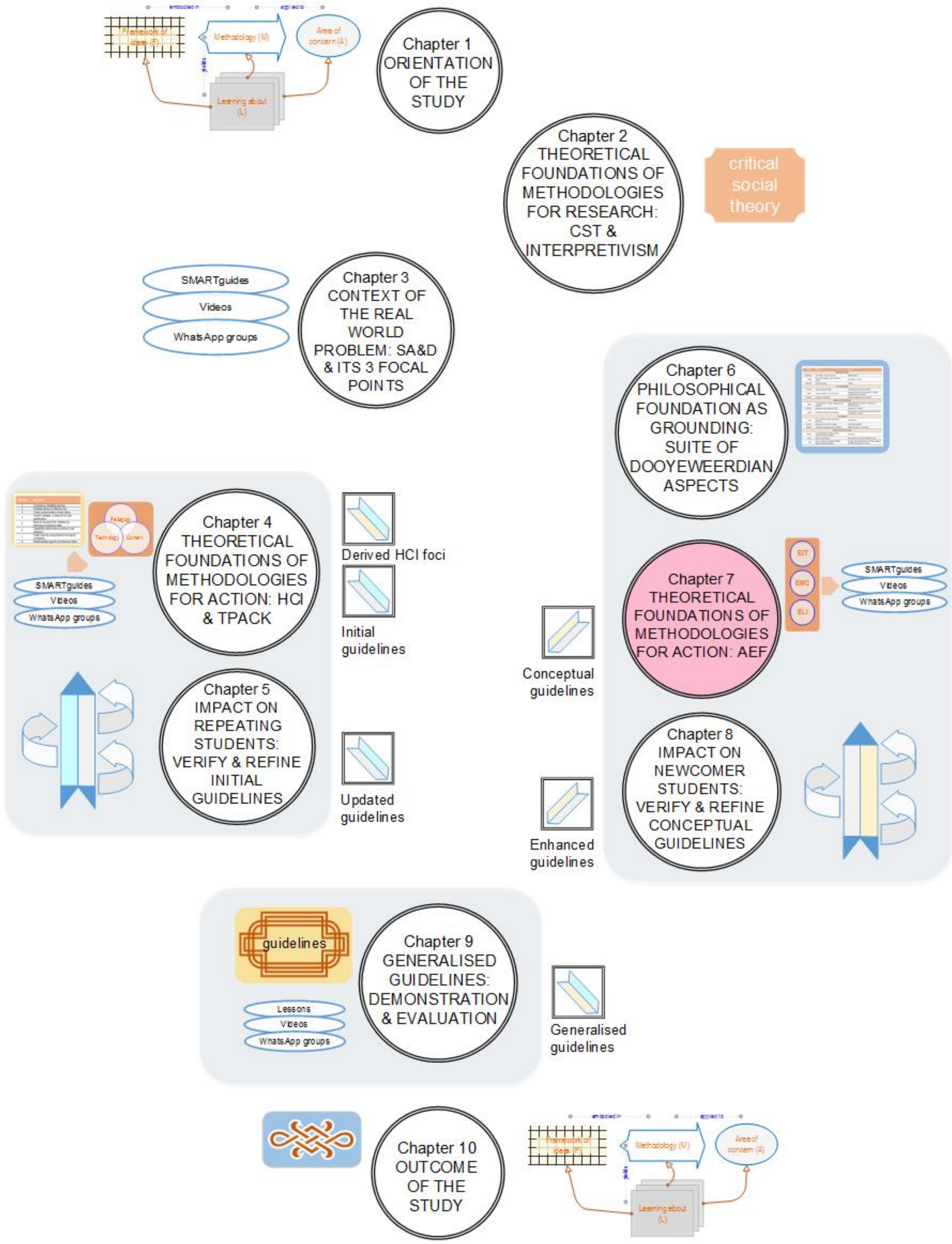
In fulfilment of this study, which is to gain an understanding of the use of technology in higher education and to develop guidelines for the use of technology, based on an understanding of HCI principles – from a Dooyeweerdian perspective, this chapter addressed the third theoretical objective (T03), namely to introduce the philosophy of Herman Dooyeweerd and investigate how his ideas may be used to gain understanding of the use of technology to learn technological subject modules (Dooyeweerd, 1969).

The extensions to the FMA model by McKay and Marshall (2001), and Mathiassen *et al.* (2012) introduced in Chapter 2 are included in this chapter. The argument with regard to this model is amended with the discourse of other authors such as Midgley (2000) and

Fuenmayor (1991). The discussion focused on the man Dooyeweerd; by whom he was influenced, his thinking, his philosophy, and in particular on his suite of 15 modal aspects, which informed F in general, and F_I in particular.

The chapterfollowing, introduces the work of Andrew Basden. His work is based on the work of Dooyeweerd to create frameworks for understanding in a technological context. This is a valuable contribution in the context of this study with its purpose to scrutinise HCI principles prevalent to the user interface.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



7 THEORETICAL FOUNDATIONS OF METHODOLOGIES FOR ACTION: AEF

7.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education based on human computer interaction principles from a Dooyeweerdian perspective.

In order to achieve this primary objective, this chapter addresses the third theoretical objective (T03), namely to assess the aspectual engagements framework, which is based on the suite of modal aspects developed by Dooyeweerd, to ascertain the successful integration of technology into teaching and learning to enhance academic success. The three separate areas of human engagements, namely engaging with interface and technology, engaging with meaningful content, and engaging in life with IS are included in the analysis (Basden, 2008; Basden, 2018). In addition, the third reflective objective (R03), is also addressed by subjecting the HCI foci derived from literature and described in Chapter 4 to its scrutiny, along with the three focal points by utilising three techniques, namely aspectual analysis, aspectual checklists, and aspectual trees to do the exploration (Basden, 2008; Basden, 2018). Conceptual guidelines are extracted with regard to the three focal points under scrutiny in this study.

In the subsequent sections, the following topics are discussed: the elements relevant to this study (§7.2), then the aspectual engagements framework, based on the work of Dooyeweerd is introduced (§7.3). The practical devices suggested for analysis is then applied to the three focal points (§7.4), with conceptual guidelines extracted as a result. (§7.5). An interview technique based on the work of Basden, is discussed lastly (§7.6). Finally the chapter is concluded with a summary (§7.7).

7.2 ELEMENTS RELEVANT TO THIS STUDY

The model developed by Checkland and Holwell (1998b:23), and expanded to include the ideas of McKay and Marshall (2001), as well as that of Mathiassen *et al.* (2012) from Chapter 2 (§2.6.2.3), is shown in Figure 7.1.

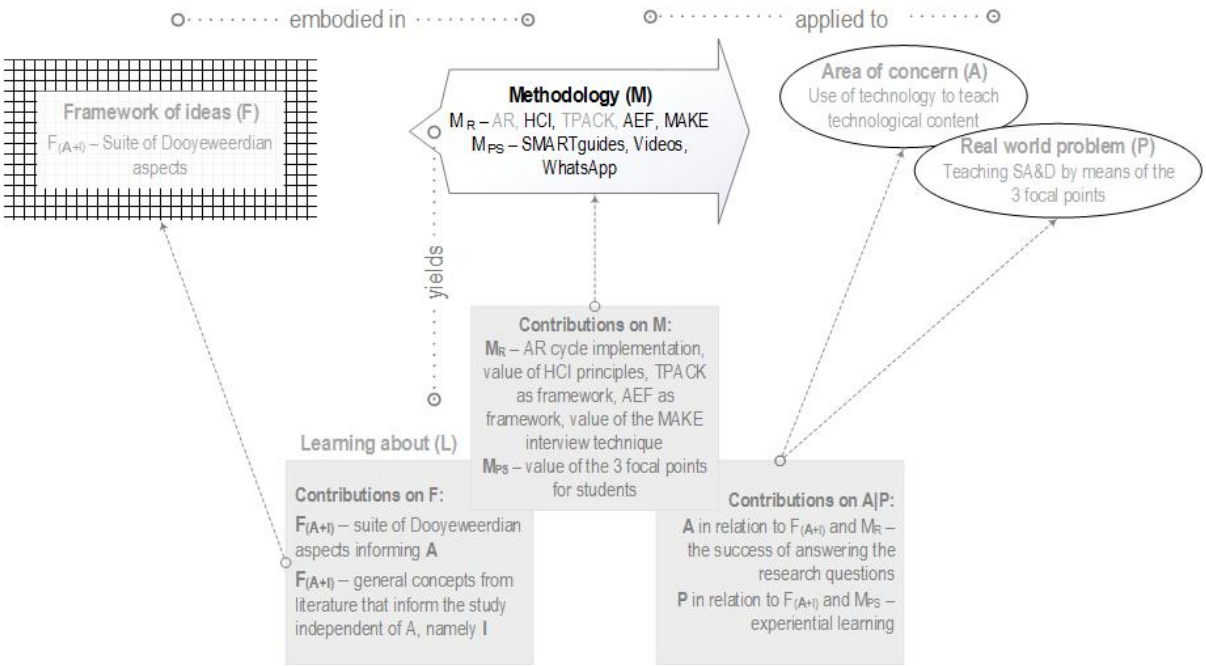


Figure 7.1: The elements relevant to this chapter

The focus of this chapter is on the discussion of methodologies (M) in the realm of problem solving (PS). It addresses the three focal points namely SMARTguides, Videos, and WhatsApp implemented in the SA&D subject offered to newcomer students (M_{PS}), and suggests and utilises the aspectual engagements framework (M_R), developed by Basden and based on the work of Dooyeweerd (F). This aspectual engagements framework (AEF), includes human use of computers, related to human computer interaction (M_R), to include the area of concern (A) with regard to this study. Enhanced guidelines represent the research part of this AR intervention (M_R).

7.3 APPLYING THE WORK OF DOOYEWEERD IN INFORMATION SYSTEMS

In the context of the role and application of philosophy in IS, Basden (Basden, 2008; Basden, 2018) made a valuable contribution – specifically regarding the Dooyeweerd Philosophy.

7.3.1 The work of Andrew Basden

Andrew Basden is emeritus professor of Human Factors and Philosophy in IS at Salford Business School in the United Kingdom. He started his career in a technological environment, initially working as a programmer, and continued to work in many foci of IS. He is the author of the Dooyeweerd pages (Basden, 2000) which provides much insight into Dooyeweerdian philosophy, as well as two books titled “Philosophical frameworks for understanding information systems" (Basden, 2008) and "The foundations of information systems: research and practice" (Basden, 2018), which focus on the application of Dooyeweerdian philosophy by suggesting a number of frameworks to facilitate the understanding of the IS world. The suite of 15 modal aspects, as suggested by Dooyeweerd, is shown to be effective in this book. Basden's developed frameworks are drawn from the Dooyeweerdian philosophy and creates accessible methods which is applicable to the IS environment. One of these frameworks in particular, is expected to provide much guidance in this study, namely the human use of computers framework.

7.3.2 Basden's categorisation

Basden (2008) applied Dooyeweerd's philosophy with the aim to develop frameworks to enable understanding in five research focus areas. The five research areas include (Basden, 2008:27):

- human use of computers,
- the nature of computers and information,
- IS development,
- IT resources, and
- IT as ecology.

Although Basden's IS development framework addresses the contents covered by the SA&D subject modules' material, it is the framework that facilitates the human use of computers that are of importance to this study since the study concerns itself with the use of technology to facilitate the teaching and learning of the module. It is discussed in the next sub-section and is used to guide the study.

7.3.3 Basden's human use of computers

The human use of computers framework (HUCF) is scrutinised with the purpose to facilitate understanding regarding its use. As a point of departure, the weakness of the frameworks for understanding (FFU) as suggested by Basden (2008), should be re-iterated; the focus of each FFU is on content, as well as strategic direction, not on research methodology as such (Basden, 2008:369). In the discussion which follows, the FFU will be treated in this way, as well as the application of the framework to facilitate the understanding of human use of computers (HUC) (Basden, 2008:120).

When seeking understanding from a Dooyeweerdian perspective, it is important to keep in mind that understanding is grounded in philosophy and is sensitive to what we experience in our daily living; aimed at encompassing its meaning, diversity, coherence and normativity (Basden, 2008:367). The suit of 15 modal aspects allows us an enriched view of the world which enables sophisticated analyses of research areas since it takes all aspects into consideration, even though it relies on an intuitive grasp and a naïve understanding of these aspects (Basden, 2008:363). When working with a complex environment such as humans using computers, Basden (2008:353) cautions us to treat its complexity with critical respect. Before discussing the HUCF suggested by Basden, it may be helpful to look at the essence of IS from his perspective (Basden, 2008:339), where IS:

- manifests as an artefact that we use in our daily lives,
- as a meaningful whole is multi-aspectual and qualified by the lingual aspect,
- is represented by the use we intend for it,
- encompasses the diversity of the meaning of our world, and
- is a world (*umwelt*) we created to live in and therefore we are also responsible for it.

The HUCF studies complex human functioning that can only be understood with a multi-aspectual approach (Basden, 2008:340). The Dooyeweerdian modal aspects allow us to distinguish between "*ease of use*" and "*usefulness*" of an artefact; it also exposes challenges and consequences of our use of computers (Basden, 2008:120). According to Basden (2008:130, 341) it consists of three different "*multi-aspectual functionings*" woven into a meaningful whole, although they may be discerned by unlike qualifying aspects. In Basden (2018), he uses different terminology; the human use of computers framework evolves to the AEF. Both the HUCF (Basden, 2008) and the AEF (Basden, 2018) are discussed:

- Human-computer interaction (HCI) – the interaction between user and computer from the user's perspective, this includes the hardware and the user interface of the software and is qualified by the lingual aspect (Basden, 2008); Basden (2018) calls this functioning *engaging with interface and technology (EIT)*, broadening its scope to include both the information mediating interface, as well as the underlying technology supporting the artefact. The guiding norm for EIT is "*ease of use*" (Basden, 2018). The latter, EIT, is used in this study when referring to this functioning, to encapsulate the broader meaning, and to distinguish it from HCI and, in this study, the HCI principles discussed in Section 4.3.1.

- Engagement with represented content (ERC), this "*multi-aspectual functioning*" was renamed by Breems (2014:48) and became "*engaging with meaningful content (EMC)*" – the user's experience of meaning in terms of content as represented by the artefact, which is qualified by the aspect reflecting the *purpose* of the artefact. Basden (2018) adopts the terminology of Breems. The guiding norm for EMC is "*veracity*" (Basden, 2018). Engaging with meaningful content may take on different significations depending on the application under scrutiny. In the SMARTguide the reference to material should be accurate, while the interaction among participants is important when using a mobile instant messaging application (MIMA), in this case WhatsApp, and when videos are presented, accurate content should be conveyed through clear visual representations and sound; each application true to its purpose. In this study, EMC is used to reflect the significance attached to content represented by an application.
- Human living with computers (HLC) – what the user go through when using the computer in daily living, which is qualified by its meaning in use. Basden (2018) calls this functioning *engaging in life with IS (ELI)*, including life at work and life outside of work. The guiding norm for ELI is "*usefulness*" (Basden, 2018). The benefit applications provide depend on the application. The SMARTguide may prove useful when preparing for a class. It will refer students to the available videos (and other resources) valuable in explaining particular concepts. A student may use the WhatsApp group to determine how to go about preparing for a test, by making sense of the material. In this study ELI is used to reflect our dependence on technology in an academic environment.

In the remainder of this study AEF (instead of HUCF) is used to reflect engagement in the three functionings through Dooyeweerd's aspects.

The three "*multi-aspectual functionings*", namely EIT, EMC, and ELI are discussed in relation to the Dooyeweerd philosophy. Basden (2008:130) relates EIT, EMC, and ELI enkaptically, meaning that they cannot be seen as a whole consisting of parts, but they are "*bound within ... to compose ... a meaningful whole*" (Basden, 2000). It is useful to identify the qualifying aspect of each of the "*multi-aspectual functionings*", because this will highlight the main meaning attached to a thing, and its purpose will be on the foreground – although all other aspects also contribute (Basden, 2008:132). Three guidelines which may be useful when identifying qualifying aspects include (Basden, 2008:135):

- refrain from reflecting the varying, immanent use of the thing, the thing itself should be reflected,
- the type of thing is differentiated from another type of thing by the qualifying aspect, and
- all other aspects should serve the qualifying aspect in a clear and innate way.

Reflecting on the qualifying aspect of each focal point per functioning: the qualifying aspects for EIT, EMC, and ELI for the three focal points of this study, namely the SMARTguides used to guide students during each semester, the videos used to explain challenging concepts, and the WhatsApp group formed to assist in students' preparation for assessment are shown in Table 7.1.

Table 7.1: Qualifying aspect of the multi-aspectual functionings of the user interface, EIT, EMC, and ELI for the three focal points; SMARTguides, Videos, and WhatsApp groups

Focal point	EIT	EMC	ELI
SMARTguide	Formative	Lingual	Kinematic
Video	Formative	Lingual	Aesthetic
WhatApp group	Economic	Lingual	Social

It is anticipated that multiple perspectives may influence a decision made on the qualifying aspect. Two important perspectives include that of the students, and the lecturer. In South Africa a student would study IT at a university to be able to build a solid career, but while students are in the process of obtaining a degree, passing subject modules are their main concern. This may indicate the *economic aspect* as prominent in the EIT sphere. From the perspective of the lecturer, each focal point should address a particular teaching and learning need – which has been outlined as instructional design, formative guidance, and summative assessment. In the end, the lecturer needs to ensure that students learn. For this reason the perspective of the lecturer is considered.

When a user engages with the **SMARTguide** interface and underlying technology (EIT), its design and accessibility guides the user in shaping his understanding in a way which achieves a mental picture of a study unit, but also allows a user to decide which information to access at a specific point in time (*formative*). It presents information (EMC) in a colourful and interactive way, including words and pictures to guide the user to enhance the interpretation of a study unit (*lingual*). Engagement in life (ELI) with the SMARTguide involves movement regarding interactivity, acquiring knowledge, through activities including access of the SMARTguide, Videos, WhatsApp group, and resources beyond the focal points, such as the text book (*kinematic*).

Engaging with **videos** (EIT) allows a user to determine one's own pace of learning – since a video may be stopped, re-winded, forwarded, or started at the user's instruction, in addition to being watched multiple times (*formative*). A video relies on sound and visual material to explain (EMC) challenging concepts (*lingual*). Videos in SA&D aim to simplify academic life (ELI) by explaining ambitious concepts to highlight the beauty of techniques and models available to the systems analyst and designer (*aesthetic*).

Engaging with a **MIMA such as WhatsApp** – on a mobile device (EIT), may entail wasting time that could have been better spent progressing in one's studies, except when the same tool is used to prepare for academic assessments, which means that time and data are used frugally (*economic*). Content (EMC) may include any number of topics, including organising logistics, sharing jokes, and supplying an answer to a subject-related question, the latter being the aim of the creation of the group (*lingual)*. Engaging with a MIMA tool such as WhatsApp (ELI), is at its core a social activity involving two or more people, and while its use in an academic setting is more formal, the underlying social nature remains (*social)*.

Two concepts are important in the AEF, namely structure and normativity. These two concepts are further explored in the next two sub-sections, with the focus on how they are applied to EIT, EMC, and ELI.

7.3.3.1 Implications of EIT, EMC, and ELI

The implications of EIT, EMC, and ELI as designed by Basden in the context of the AEF is explained in this section to facilitate its understanding, as well as its application to this study.

In the case of EIT, the computer in itself is represented (Breems, 2014:38), along with the artefact. Basden (2008:137) states it to be a subject-subject (S-S) relationship between a human user and a computer; this is prevalent in the physical aspect since both are subject to the laws governing that aspect, enabling genuine interaction. It is true that EIT obtains its meaning from a later aspect – in most cases the lingual aspect, which means that we cannot reduce EIT to the physical aspect, and the *sensitive*, *analytical*, *formative* and *lingual aspects* are getting the most attention in EIT. Beyond the physical aspect, the user functions as subject, and the computer as object (S-O) where the aim is for the user to have a seamless experience with the computer (Basden, 2008:138). Viewing EIT from this perspective allows all aspects a place in EIT; it also allows the researcher a way to evaluate and design (Basden, 2008:139).

The EMC goes beyond what EIT liaises, it represents the content projected by the application under consideration (Breems, 2014:38). This is possible through aspectual extension or "*reaching out*" (retrocipation or anticipation) from the enabling lingual aspect to all other aspects (Basden, 2008:142). Although it is mostly the function of the *lingual aspect* to mediate other aspects through the user's engagement with the interface, it may also be the function of the *formative aspect* when content is active in the mind (memory) of the user. A last mediating aspect identified by Basden, is the *analytical aspect*, which happens when the user makes deductions. In addition to aspects acting as enablers, the activity of using an artefact can also be an enabler of other aspects; this is often seen in the use of artefacts to play games.

When it comes to ELI, the aspects pertaining to everyday life of people are important (Basden, 2008:142). Since each aspect has laws in which it functions, the functioning in an aspect incurs reverberations or repercussions which may be unpredictable. Although prediction is uncertain, if analysis is done with care, prediction may be useful on issues including diversity, indirect and unexpected affects (Basden, 2008:143). Reverberations may be positive or negative and originates with a particular aspect; one may therefore expect a number of types with each ELI instance.

***An illustration – reflecting on WhatsApp group reverberations and repercussions**:* in the early days of using MIMAs, it allowed as little as 16 people in a group, which forced the forming of multiple groups (*quantitative*); when the lecturer does not make students aware of the fact that one need to take yourself and others into consideration when using MIMAs, the groups get flooded with useless information (*formative)*, and using the MIMA group facilitates the learning of students' names (*social)* – all representative of diverse reverberations. Since ELI functions in a particular aspect, the most direct reverberations are expected in that aspect. An example in the MIMA (*social*) includes the use of a particular language – in this particular case, Afrikaans or Sesotho, causing students who cannot express themselves in either language to be offended. This is particularly true in the context of this study where the South African setting allows for 11 official languages. A direct impact may also have a longer term bearing when the effects of a misunderstanding affects secondary users in the originating aspect, as well as in other aspects (Basden, 2008:144). In the case of unexpected impacts some aspects may be overlooked in the use of a MIMA such as WhatsApp, but they will manifest as unexpected impact since the law of that aspect pertains.

7.3.3.2 Normativity of EIT, EMC, and ELI

Normativity, a philosophical issue, refers to how things are supposed to be done; it deals with good and bad, and how it is integrated with our daily living (Basden, 2008:147). Normativity is intrinsic to the AEF functionings, as well as the Dooyeweerdian aspects (Breems, 2014:221). Although Basden (2008:147) suggests a superordinate normative objective of EIT, EMC, and ELI, he also proposes that all human engagement should endeavour to incorporate all aspectual norms – in a way which highlights the singularity and integrity of the engagement. The normativity of the three functionings is considered next.

When it comes to EIT, usability is the most important norm, but special care should be taken to ensure that the focus of usability is not limited to one or two aspects, for instance having a "stunning" interface, or being productive (Basden, 2008:147). Focusing on any one aspect at the expense of another, influences usability negatively. Therefore EIT is dependent on the Shalom principle which requires harmony and balance among aspects (Basden, 2008:105). When conflict is experienced between aspectual norms, advice from Basden (2008:148) directs towards the use of the qualifying aspect as determining factor, not just in EIT, but also those of EMC and ELI. Breems (2014:62) adds to this argument that although human functionings are encompassed by EIT, EMC, and ELI, "*the user of the computer, primarily at the time of use*" is the focus of AEF. Thus, the emphasis is on EIT. He examined the interaction of normativity between EIT and EMC, facilitated by the computer, and that of ELI, facilitated by humans, and listed eight possibilities. Breems (2014:62) provides a "*normative or antinormative*" distinction which may over-simplify the focal points, but when arguing about the type of relationships between the functionings, it may be a guide to how the three functionings interact. Antinormative in this instance would be an effect against the expected norm. His verbal binary distinction is shown in Table 7.2.

A context sensitive example - reflecting on a WhatsApp group*:* we may consider a group of SA&D students communicating on the WhatsApp group created for the subject module. Some students are sharing problems they encounter in studying for a test, while others are supplying the potential answers to these questions. The interaction is gratifying; the interface is well designed and intuitive; there is camaraderie and laughter in the air – since peers pull one another's leg while solving problems. In short, there is normative functioning among EIT, EMC, and ELI.

Table 7.2: "Normative or antinormative" distinction between EIT, EMC, and ELI adopted from Breems (2014:62)

No.	Interaction of normativity	Status examples from the study
1	Normative functioning in EIT and EMC results in normative ELI functioning becoming even better.	Using the WhatsApp group to ask a question (EIT) while studying for a test, and getting a prompt answer (EMC) may result in motivating the student asking the question and possibly other students who struggle with a similar question (ELI).
2	Normative functioning in EIT and EMC results in normative ELI functioning becoming somehow worse.	On the WhatsApp group (EIT) many students may ask difficult questions that is not answered immediately (by the lecturer) and a diligent student may get involved and spends a lot of time in providing the correct answers (EMC), possibly to the detriment of his or her own preparation (ELI).
3	Normative functioning in EIT and EMC results in antinormative ELI functioning becoming not as bad.	On the WhatsApp group (EIT) many students may ask difficult questions that is not answered immediately (by the lecturer) and a diligent student may get involved and spends a lot of time in providing the correct answers (EMC), (s)he may be worried that this takes up too much time from her or his own preparation, but finds that some of these questions are asked in the test (ELI).
4	Normative functioning in EIT and EMC results in antinormative ELI functioning becoming even worse.	In preparation for a test a number of students may ask difficult questions on the WhatsApp group (EIT) which is then answered by a group of students (EMC), creating a buzz which motivates the participating WhatsApp group members. A student that is not yet fully prepared and for this reason is not actively participating in the discussion may be de-motivated by what (s)he reads about the question-answer combinations (ELI).
5	Anti-normative functioning in EIT and EMC results in normative ELI functioning becoming somehow better.	On rare occasions interruptions in the WhatsApp service may cause forced downtime (EIT). Should this happen at a peak test preparation time, students will struggle to communicate via MIMAs (EMC). In some cases it may result in them focusing their time on preparing for the test and not reading WhatsApp messages (ELI).
6	Anti-normative functioning in EIT and EMC results in normative ELI functioning becoming not as good.	On rare occasions interruptions in the WhatsApp service may cause forced downtime (EIT). Should this happen at a peak test preparation time, students will struggle to communicate via MIMAs (EMC). In some cases it may result in them getting at a point where they cannot figure out what to do next – for them to be able to progress well in preparing for the test (ELI).

No.	Interaction of normativity	Status examples from the study
7	Anti-normative functioning in EIT and EMC results in anti-normative ELI functioning becoming not as bad.	When offering an important lecture, a weak internet signal (EIT) will disable the availability of social media (EMC), resulting in students focusing on the presentation by the lecturer and activities among small groups of students (ELI).
8	Anti-normative functioning in EIT and EMC results in anti-normative ELI functioning becoming even worse.	On rare occasions students new to a large WhatsApp group, such as the ones used in SA&D (EIT) would get involved in a discussion that does not contribute to the purpose of the group (to provide support when preparing for assessment), resulting in a large number of irrelevant messages produced in a short time-span (EMC). Students who are diligently using the forum for its purpose may become discouraged.
Important: in any given situation, only one possibility from each pair can be true. If one is the case, then two is not. If eight is true, then seven cannot be.		

When using the binary distinctions supplied in Table 7.2, there is a possibility that should the functioning of EIT and EMC be improved, it might cause the ELI functioning to be degraded (refer to number 2 listed). Also, when ELI is functioning normatively, it may be in spite of EIT and EMC not functioning optimally, rather than because of it (refer to number 5 listed). This implies that when compromising the normativity of EIT – which may involve having an awful interface that confuses the user and costs too much – may actually improve the ELI functioning.

Basden (2008:148) discusses two possibilities in terms of how the EMC normativity may be treated;

- the first option is to treat it in the same way as was suggested with EIT and ensure that all aspects serve the purpose (qualifying) of the EMC, but since the purpose of an artefact may change during use, this approach may be detrimental to the flexibility of the software, so
- the second, more beneficial strategy which allows for flexibility, ensures that the artefact conveys the full meaning in terms of content – in the domain of application.

The latter strategy uses the juridical norm and focuses on what is due. Basden (2008:149) suggests supporting norms, including addressing diversity, fitting the user, addressing richness, trustworthiness of all active aspects, and flexibility.

In the context of ELI, the success of an artefact is not judged in technical terms only. In addition to IS enhancing productivity; meeting objectives, supporting satisfaction of users, and emancipating users are also important (Basden, 2008:150). These may be understood using the Shalom principle, as well as the intrinsic normativity of aspects, as suggested by Basden (2008:151). The Shalom principle asks of us to seek the good in every aspect, regarding its functioning – expecting good reverberations. Breems (2014:66) links the Shalom principle to the normativity interactions listed in Table 7.2; shalom is encapsulated by a deeply experienced sense of welfare and is attained when normative functionings in all the aspects are prevalent. When scrutinising a particular action, some aspects may have normative functioning, while others have not. In the case of the clarity of visual material shared on WhatsApp, the improvement of this functioning may result in more students asking questions and likewise more supplying answers. The Shalom principle is therefore not only true for the aspectual functioning, but also that of EIT, EMC and ELI; when these functionings are normative, the human use of computer experience becomes optimal. Although this conclusion may be self-evident, it becomes complex as soon as these functionings are not normative, since the expert needs to identify which functioning is not normative. The aspects can help a great deal in this identification process.

7.3.4 Towards the application of practical devices for analysis of phenomena

Critically viewing the discussion of the AEF above, the understanding it facilitates is of value, but Basden (2008:153) also suggests practical ways to plan the intervention. He suggests a number of practical devices which may be of use in research and practice of aspectual engagements, including an aspectual checklist, aspectual analysis, and the aspectual tree. With the anticipated action of and direction in an empirical intervention discussed, the researcher needs to follow the directed actions, based on the guidance provided by Basden. The three devices are discussed here.

7.3.4.1 Aspectual checklist

According to Basden (2008:154) normativity pertains to all the aspects, and it supplies a basis for the establishment of guidelines and the evaluation of user interfaces of computer systems. The use of the Shalom principle of the concurrent actualisation of norms, centres on the importance of all aspects, although one, the qualifying aspect, may be the focus. This helps us to give the duly allotted focus to all aspects and not to over-accentuate some. In the context of this study, the Shalom principle would be violated if the SMARTguide has the "*most amazing*" graphics, but its contents are not useful to students – resulting in it not being utilised to its full extent, if at all. A form of aspectual analysis that is useful in guiding the evaluation of user interfaces is a checklist where the important aspects per guideline are indicated. Basden (2008:155) encourages the use of the checklist primarily as an evaluation tool to suggest improvements to such principles and not only as a tool to criticise.

7.3.4.2 Aspectual analysis

Aspectual analysis requires reporting on how each aspect manifests in the situation which is analysed. Basden (2008:153) cautions against only supplying examples per aspect, extensive analysis should be done. Aspectual analysis may be done in various ways; they include the analysis of texts such as the analysis of WhatsApp conversations, brainstorming multi-aspectual functioning such as the analysis of the videos, analysis of represented content such as the analysis of the use of a SMARTguide, and analysis of distinct, but interwoven multi-aspectual functionings, such as EIT, EMC, and ELI in the aspectual engagements context. One can also analyse a particular view of a research situation, such as the usability of a tool, or its benefits (Basden, 2008:153). The value of aspectual analysis of computer use is to identify "*ways in which things may be meaningful*" (Basden, 2008:127), and when we use technology, we do things that impact us and those around us in the form of reverberations (Basden, 2008:127). Also, aspectual analysis may be used as a basis when critically evaluating a situation; the number of aspects represented, balance, or lack thereof, among aspects, and gaps in the representation of aspects may guide critique (Basden, 2008:155). In the context of this research, Dooyeweerd may take us beyond critique (Basden, 2008:303); it is used to ensure quality and to induce the consideration of alternatives by anticipating possible uses (Basden, 2008:253).

7.3.4.3 Aspectual tree

According to Basden (2008:156) a fir tree as a simple visual representation technique may be useful to render an overview of aspectual normativity. For a similar purpose Breems (2014:215) uses a grey scale shaded heat-map, with lighter shades representing lesser significance and darker shades representing greater significance. The aspectual fir tree as a double-sided bar chart representation is more useful in the sense that it allows for positive and negative effects, such as in the case of functioning and reverberations. It is also possible to show positive and negative effects on one aspect (Basden, 2008:156). The length of each bar is used to indicate how strong the negativity or positivity of each aspect is. Such a visual presentation shows benefits and challenges at a glance. It may be used retrospectively when looking at tools in use, or prospectively when design or prediction is under scrutiny (Basden, 2008:157). Since the aspectual tree may give us an over-simplified representation of a situation, care should be taken:

- The length of a bar should not represent aspectual functioning, also two bars should not be compared regarding their length.
- Patterns and groups of aspects behaving similarly may tell a story; an example would be positive functioning in the earlier aspects which manifests earlier occurring along with negative functioning in the latter aspects which manifests over a longer period of time – such a project may initially falsely be labelled as successful.
- The longer and shorter (or zero) bars should be revised and possibly be redrawn to ensure that they are correctly represented, but it should always be kept in mind that people's understanding of the aspects are variable; in the case of this study the author as researcher and lecturer, the researcher as analyst, and the students participating in various groupings (Basden, 2008:158).

The recommendation of Basden (2008:158) is to use the aspectual fir tree to facilitate the focus of further analysis, as may be done using the Multi-Aspectual Knowledge Elicitation (MAKE) (Winfield, 2000) and/or Multi-Aspectual (Kane, 2005) interview techniques. In this study a fir tree was developed for each of the three focal points. The fir trees have been included in Annexure D: "*AEF – FIR TREES*". Although the fir trees are not explicitly included in the study, they are implicitly utilised to guide the interviews to be conducted, to verify and refine the conceptual guidelines.

7.4 APPLICATION OF PRACTICAL DEVICES ON THE THREE FOCAL POINTS

The aspectual expression of the three focal points are done through aspectual analysis – with the focus on the three human engagements, namely engaging with interface and technology (EIT), engaging with meaningful content (EMC), and engaging in life with IS (ELI); the aspectual checklist – including all of the 15 modal aspects and checking the relevance of each to a particular item that forms part of the research; and aspectual trees – a visual presentation of benefits (engagements) and challenges (repercussions) on a double-sided bar chart. All of the instruments suggested to aspectually express the study will be utilised to varying degrees, but since Basden (2008) does not suggest any prescribed order to this expression, a logical order is implemented. First, an aspectual checklist is completed which builds on the HCI principles derived from literature and compiled in Chapter 4 (§4.3.3). Secondly, the aspectual analysis of the three focal points are done, applying the functionings of the AEF described in this chapter. Lastly, the three focal points of this study are analysed by using aspectual trees. In this study the fir trees are included as an annexure, per focal point. The fir trees may be used to visually amend the understanding of the reader regarding the benefits and challenges associated with each focal point - per aspect – as perceived by the researcher.

With the intention to represent the application of the practical aspectual devices suggested by Basden – on the three focal points of this study – a visual presentation is shown in Figure 7.2.

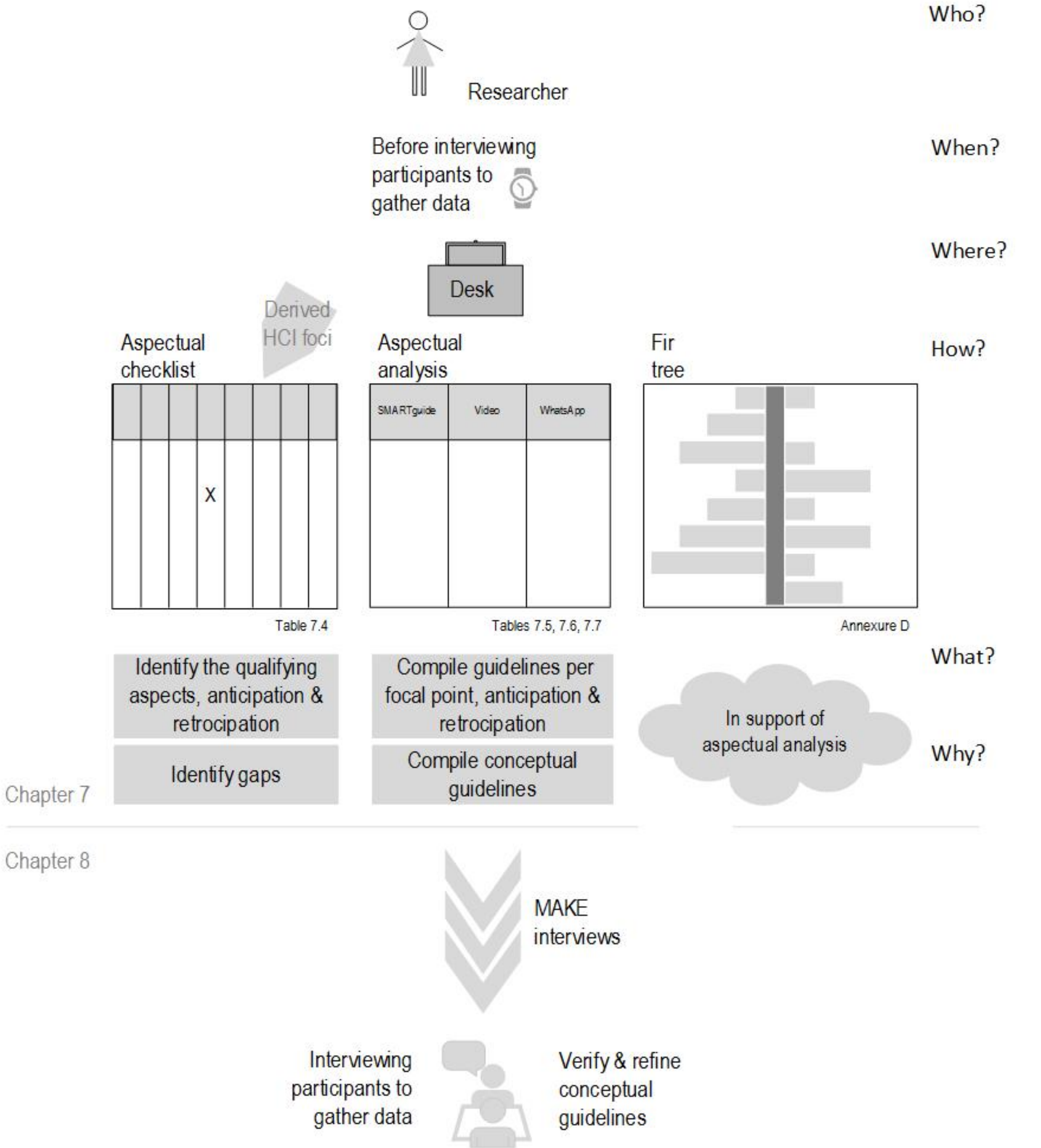


Figure 7.2: The application of aspectual devices in this study

Six basic questions, namely *Who? When? Where? How? What?* and *Why?* has been answered in the visual presentation. The "*how?*" question is answered in the subsections following. To answer the "*how?*" question, the "*what?*" question need to be answered. This is done by identifying aspects which are linked to the derived HCI foci, and compiling guidelines for the focal points. In this process, attention is given to retrocipation and anticipation of aspects. In answering the questions listed above, the "*why?*" question is answered. The aspectual checklist extracts gaps represented by aspects not expressed through the derived HCI foci. Doing aspectual analysis, extracting guidelines, each one is matched with one of the modalities. In this study, the fir tree supports the aspectual analysis.

7.4.1 Aspectual checklist of the derived HCI foci

The derived HCI principles identified as foci applicable to this study, is aspectually mapped with the Dooyeweerdian suite of 15 modal aspects – the purpose being to identify gaps. This is done intuitively in Table 7.3. The order of importance attached by the Hinze-Hoare (2007) study to the foci, was again listed here.

Table 7.3: The derived HCI foci applicable to this study, aspectually mapped

Pos	Derived HCI focus	Explanation	Aspectual mapping of qualifying aspects
1	Consistency and familiarity facilitate learning.	The familiarity with which an artefact links with one's world, its standardisation and consistency, and generalisability across artefacts assists one in learning to use it.	Logical
2	Guide users by using physical and logical constraints.	Guidance should be provided to the user, with the focus on recognising what needs to be done, instead of remembering it.	Formative
3	Flexibility allows for effective use.	Flexibility with regard to changing the interface, or creating shortcuts to allow multiple ways to perform a task.	Formative
4	Prevent mistakes, or allow for its clear identification.	The design of an artefact should include the anticipation of mistakes with the purpose to prevent errors, but when they occur, error messages should be clear in identifying the mistake.	Aesthetic
5	Allow for recovery from mistakes by returning to a previous state.	Recovering from a mistake by returning to a pre-mistake state by reversing errors. Instructions to guide the user may be helpful.	Sensitive
6	Capabilities performed according to user intentions.	Tasks are performed by the user, through the assistance of an artefact – this means that the initiative migrates between the user and the artefact. It is important that, although the initiative may migrate, the locust of control should be with the user to ensure that the artefact's capabilities are performed according to user intentions.	Formative

Pos	Derived HCI focus	Explanation	Aspectual mapping of qualifying aspects
7	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses.	A task a user needs to perform, should involve a dialogue thread. Measuring human perception allows the improvement of computer interfaces for use by humans. Humans perceive their environment through their senses (see, hear, touch, smell, taste).	Spatial Sensitive
8	Timely communication of task status.	While an artefact is busy with a task, and upon its completion, prompt, visible and informative feedback should be provided regarding the changing and current state of the artefact.	Lingual

This mapping indicates that the contribution of the philosophy of Dooyeweerd may be of value in conducting the research in this study. No mapping is made to the quantitative, kinematic, physical, organic, social, economic, juridical, ethical and pistic aspects – which may prove to be significant further on in the study.

Normativity is embedded collectively in all the aspects, realising the Shalom principle and forming a basis for the compilation of guidelines to be used in human computer interfaces, such as is the case in this study (Basden, 2008:154). A norm is a standard for making a judgment regarding good or evil behaviour. Although normativity is built into aspectual functioning (Basden, 2018:73), evil does not pertain to the first four aspects (*quantitative, spatial, kinematic & physical*). Also, good functioning results in consequences which are beneficial (Basden, 2018:78). All aspects are important, but the qualifying aspect(s) is/are the focus. The full development of consequences differs depending on the position of each aspect on the list; the first aspects (*quantitative to sensitive*) has immediate consequences, while subsequent aspects (*logical and formative*) takes seconds, minutes (*lingual*), hours (*social*), days (*economic*), weeks (*aesthetic*), months (*juridical*), years (*ethical*), and lastly decades (*pistic*).

In this section, each HCI principle identified as important to this study is discussed in the context of the 15 Dooyeweerdian modalities. The meaning embedded in each identified principle is revisited, and then the qualifying aspect(s) is/are identified. After the discussion the aspectual analysis of the HCI foci, is represented as a checklist in Table 7.4.

The Shalom principle determines that every aspect is important, but (a) qualifying aspect(s) stand(s) central to each rule. A qualifying aspect may reach toward earlier aspects (retrocipatory), or it may reach toward later aspects (anticipatory).

The rule, ***consistency facilitates learning***, includes the consistency of a design (Nielsen, 1994:30; Shneiderman, 1992:60), and its standardisation within an implementation (Norman, 2013:72) to enhance its learnability (Dix *et al.*, 2004:264). This rule has as qualifying aspect the logical, which encapsulates conceptualisation, clarification, and categorisation, while it retrocipates the kinematic – representing change that is inherent to an application, and anticipates the formative – where we deliberately shape our environment through creativity.

The rule, ***guide users by using physical and logical constraints***, creates the expectation that an artefact would assist a user in the execution of a task (Dix *et al.*, 2004:261). The qualifying aspect is the formative, since the performance of tasks shapes our world. It retrocipates the kinematic – bringing about change, and anticipates the juridical – by giving what is due.

The rule, ***flexibility allows for effective use***, requires the artefact to be customisable by the user (Dix *et al.*, 2004:269). Substitutivity, should be prevalent here (Dix *et al.*, 2004:268) – where more than one option exists to acquire the same action in the artefact, of which one should be a shortcut which may be useful to regular users (Nielsen, 1994:30; Shneiderman, 1992:60). The qualifying aspect being the formative, which deliberately and creatively shapes our world. It retrocipates the sensitive – engagement with the world in an interactive way, and anticipates the juridical – representing due for all.

The rule, ***prevent mistakes, or allow for its clear identification***, prioritises the prevention of errors, and includes error message instructions regarding the treatment of errors that cannot be prevented (Shneiderman, 1992:60). The qualifying aspect is the aesthetic, with its purpose to create a harmonious environment to work in. It retrocipates the economical by being frugal and anticipates the juridical by supplying what is due.

The rule, ***allow for recovery from mistakes by returning to a previous state***, indicates the ability of an artefact to recover from mistakes made by a user (Dix *et al.*, 2004) by returning to a previous state (Nielsen, 1994:30; Shneiderman, 1992:60). The qualifying aspect is the sensitive, with evidence of interactive engagement with the world. It retrocipates the kinematic – change facilitates recovery, and anticipates the ethical – by giving more than is due without being judgemental.

The rule, ***capabilities performed according to user intentions***, means that the user controls the artefact (Norman, 2013:72; Shneiderman, 1992:60), but that a form of communication exists between the user and the artefact and parts of an action may be done by each party (Dix *et al.*, 2004:266). The qualifying aspect is the formative, where the user shapes actions. It retrocipates the sensitive – representing the user who actively engages with the world, and anticipates the lingual – where interaction between a user and an artefact assumes to be a conversation.

The rule, ***multithreading supports simultaneous tasks, multimodal dialogue include all human senses***, refers to interaction of simultaneous tasks to fulfil a common purpose, as well as understanding our environment through our senses (Dix *et al.*, 2004:267). The qualifying aspects are the spatial, with multithreading having simultaneity because its parts are all simultaneously present (Basden, 2000), as well as the sensitive with multimodal dialogue representing humans' interaction when we "*speak about, point at, and look at objects*" simultaneously (Sharma *et al.*, 1998:854). Multithreading has no retrocipating aspect and anticipates the juridical with what is due being forthcoming. Multimodal dialogue retrocipates the organic since the fact that humans are alive affords them vitality and anticipates the ethical, giving more than is due.

The rule, ***timely communication of task status***, means that quick, clear and meaningful dialogue indicating a state while performing an action, as well as thereafter should be relayed to the user (Dix *et al.*, 2004:262; Nielsen, 1994:30; Norman, 2013:72; Shneiderman, 1992:60). The qualifying aspect is the lingual, with dialogue being an expression. It retrocipates the formative – where the effect of past actions on the current state enlightens the user, and anticipates the aesthetic – it is harmonising with the artefact.

In Table 7.4, the 15 modal aspects (listed horizontally) per focus (listed vertically) – to indicate the important aspects per focus, visually. Basden (2008:155) suggests using the first letter of each aspect in the table, such as quantitative (Q), and juridical (J). Here this suggestion was amended to include the second letter when there is more than one occurrence of the first letter, for example with spatial (Sp), sensitive (Se), and social (So). An "**X**" indicates a qualifying modality. while "x" indicates applicability in the mind of the researcher. In one case an additional distinction is necessary, namely HCI focus 7 including "*multithreading*", where the status quo is applied, and "*multimodal* dialogue" where a curly "***X/ x***" is used to distinguish between the qualifying modality and applicability. The grey area in the table highlights applicability concentration.

Table 7.4: Aspectual checklist of the derived HCI foci applicable to this study

Pos	Derived HCI focus	Q	SP	K	Ph	O	Se	Lo	F	Li	So	Ec	A	J	Et	Pi
1	Consistency and familiarity facilitate learning.			x				X	x							
2	Guide users by using physical and logical constraints.			x					X					x		
3	Flexibility allows for effective use.						x		X					x		
4	Prevent mistakes, or allow for its clear identification.											x	X	x		
5	Allow for recovery from mistakes by returning to a previous state.			x			X								x	
6	Capabilities performed according to user intentions.						x		X	x						
7	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses.		***X***			x	X							***x***	x	
8	Timely communication of task status.								x	X			x			

Basden (2008:155) advises that the aspectual checklist should be used as instrument – not to criticise, but for the purpose of suggesting future improvement. In the context of this study, the aspectual checklist will be used to guide the interviews to be conducted to verify the aspectual analysis, reported on in subsequent chapters. With the meaning of the word *verify* being to "*make sure or demonstrate that (something) is true, accurate, or justified*" (Oxford, 2008), and amendment is suggested, namely to verify and refine, to ensure the enhancement of the guidelines.

When studying the aspectual checklist of the derived HCI foci applicable to this study, it seems as though the concentration of modal aspect representation is in the middle of the table, including only four modal aspects, namely the sensitive, logical, formative, and lingual aspects (the shaded area of Table 7.4). As may be expected, the first five aspects – quantitative, spatial, kinematic, physical, and organic – which have determinative functioning and allow limited freedom of response and therefore are recommended to be omitted during interviews, are under-represented. The organic, kinematic and spatial aspects are the only representations, with only the organic as qualifying modality. Of the last six aspects – social, economic, aesthetic, juridical, ethical, and pistic – the social and pistic modalities are not represented at all, while only the aesthetic is represented as qualifying modality. The gaps that were intuitively identified in Section 7.4.1, to be quantitative, kinematic, physical, organic, social, economic, juridical, ethical and pistic (nine in total), are now narrowed down to quantitative, physical, social, and pistic (four in total). These four gaps in the representation of modalities indicate non-represented areas of the HCI foci. These gaps may be contended for through the identification of guidelines in the use of technology in education, which is the ultimate purpose of this study.

7.4.2 Aspectual analysis of the focal points

The purpose is to obtain conceptual guidelines to be verified and refined by means of interviews. The situation to be analysed, in this study the focal points of instructional design, formative guidance, and summative assessment, should be listed in the aspectual analysis according to how each manifests. Documents are the source of information that guides the aspectual analysis. Three groups of documents are utilised in this study:

1. Instructional design is represented by the SMARTguides; content analysis is based on knowledge of its contents.
2. Formative guidance realises in the form of videos; brainstorming of multi-aspectual engagements informs its analysis.
3. Preparation for summative assessment is implemented as WhatsApp conversations; participation in the process informed the analysis of text.

Engaging with interface and technology (EIT) as discussed above, does not realise its full meaning unless it is enabled by the engagement with meaningful content (EMC), as was done in the third column (EMC). In the last column (Combined guideline), the guideline(s) that may potentially be drawn from that particular row is formulated. It is anticipated that the engagement that distinguishes the three focal points incorporated in this study from other technology tools, will be represented by that of engagement with meaningful content (EMC).

In the following three sub-sections, the guidelines derived from the SMARTguides, Videos, and WhatsApp groups are summarised, taking its aspectual analysis into consideration. Eventually the discussion incorporates the derived HCI foci from Section 7.4.1.

7.4.2.1 Instructional design – the SMARTguide

Regarding the world of engagement with meaningful content (EMC), the SMARTguide is a representation of guiding academic progress in a particular module. In Table 7.5 each of the aspectual engagements are firstly listed individually, and then merged to list a combined guideline. The phrases from each engagement that may contribute to the formulation of the combined guideline is shown in **bold**.

Table 7.5: Aspectual analysis of the SMARTguide used for instructional design

Aspect	EIT	EMC	ELI	Combined guideline
Q	Since it is **an electronic guide**, pages are not limited. Visual material on the screen. Number of downloadable devices accommodated.	The number of **study units and guiding concepts per study unit** (implemented as tabs) should cover all module activities.	The material included in the subject module should be **guided** by the SMARTguide.	An electronic guide should allow the inclusion of all the material necessary to guide the subject module.
Sp	Screen layout – **available space per page** should be used well. LMS restrictions regarding capacity allows for 50MB to be loaded per item. Space student is in while accessing the SMARTguide. Size of devices used to view content.	A **logical unit of information should be conveyed per page**, but the available space per page limits what is presented. In many cases, mobile devices, with small screens, are used for access.	A SMARTguide is loaded on the LMS (eFundi). It is downloadable onto **any electronic device** with Adobe Acrobat software installed to read the SMARTguide. To make this work, students need to take the time to download the SMARTguide. Without Internet access, videos and eFundi-links will not be active.	Logical units of information should be conveyed per page, taking screen size into consideration.
K	**Interactivity of material**, **movement while navigating** the SMARTguide (typing, reading), easy paging to find a topic, order and flow of topics should be logical. Moving the mouse, utilising one's fingers, tilting the device to enable content.	**Accessing the SMARTguide** allows continuation from a previous session ("do you want to resume where you left off?"). Movement among pages, general content, study units, and tabs should be fluid, while **access to supportive environments** are paramount.	In the case where a student made the effort of **downloading the SMARTguide** onto his/her phone, not much movement is required to access it to view a study unit in preparation for a class. Otherwise, access to the eFundi LMS is a pre-requisite.	Electronic guides should be interactive, while fluid movement between pages/tabs, and units, expansion via Internet access to include supportive environments (such as eFundi), and fluid access between sessions are a necessity.
Ph	Emission of light and sound. Availability of a touch-screen, material the device is made of.	– –	A state of inertia, with little expenditure of energy, is sufficient to view a study unit. A student working through a study unit may gain a better understanding of the outcomes by accessing the material the SMARTguide directs students to (text book, videos, project, etc.) – while making notes.	Electronic guides should allow access to all the necessary material in one place – the device used to access the material. Such access may require an active Internet link.

Aspect	EIT	EMC	ELI	Combined guideline
O	Allowance for **compact learning sections** as part of each study unit to accommodate users' short term memory. Engaging the visual-aural-tactile senses with a screen, speakers, mouse/ keyboard/ touch-screen. Emissions from the screen and speakers.	A **limited number of facts are presented per page** and only one activity per tab to support the short term memory of the student.	**Visual material** in the form of text, pictures, interactivity and videos – applied to a study unit should be sympathetic to all that is biotic.	Only a small number of facts should be represented per page (a maximum of seven facts would support short term memory), a variety of visual material, engaging all the human senses will support learning.
Se	**The use of colour and sound** to help students recognize and identify important concepts. The inclusion of videos to guide difficult concepts. Sensitivity of mouse, keys, or the screen, movement of the mouse. Seeing the screen and hearing the speakers.	A **colour theme** is used for each SMARTguide, this is helpful in SA&D II, where the SMARTguide of SA&D I is referenced as well. The use of colour and movement is utilised in some of the interactive self-assessments where terms need to be matched with descriptions.	When using the SMARTguide to guide one's studies, a student who spend the time to prepare for a class may **feel in control**, satisfied, content. Upon not being prepared, a student may feel overwhelmed, causing feelings of frustration, or dejection.	Sensory stimulation may aid the learning process. The use of colour and sound extend the vehicles introduced in the preceding modal aspect (organic).
Lo	**Creating awareness of important work** through the effective use of icons, text and numbers emphasized through use of font, bold, and italics. Ensuring a device download is completed to access the SMARTguide on the selected device.	A **logical breakdown of the guidance** incorporated includes tabs such as "prepare for class", "reminders & homework", and self-assessment "activity". Icons of arrows and sliders are used to guide progress.	The **ability to distinguish** between continuous work with irrefutable results over the semester, and constant procrastination.	A similar layout highlighted with tabs – to allow individual access – that progress in a logical way, should be used to guide the learning of each study unit.
F	Layout of screen with main area, toolbars and tabs. **Setting outcomes** per subject module and study units, use of tools to perform specific actions. The SMARTguide does not run on my device (because flash player is not loaded).	Although an escape is built in and guidance is provided, a student should not progress beyond a self-assessment activity unless it is correctly answered. The order of the tabs are designed with logical progress in mind, but students may utilise contents according to personal needs. **Deeper guidance are embedded in pages accessed via the tabs.**	The purpose of the SMARTguide is to **shape the learning** that needs to take place before a class is offered.	Building on the preceding modal aspect (logical), the formative has the aim to guide the student to either progress through the material, or to access material and be guided from general knowledge to detail. The latter may be just-in-time material needed to perform a task, such as completing an assignment.

Aspect	EIT	EMC	ELI	Combined guideline
Li	Communication from lecturer to student, guiding the student's learning through meaning of icons used, the message menus convey, content included per screen – in such a way that it **supports students' studies** in the subject modules. Labelling of video on how to install your variety of devices SMARTguide versions.	Only **essential information** is provided per tab. In the SMARTguide students are **referred to resources** which will allow them access to deeper understanding.	– –	A SMARTguide is a lingual resource, which allows the acquisition of knowledge through the lingual. Therefore information presented may be diverse, but should convey the same message.
So	Assumptions shared between the SMARTguide designer-developer (lecturer) and the users (students) from **different cultures**; user interface standards implemented; conformance to NWU standards and guidelines. Technology is a status symbol.	– –	– –	In principle, a SMARTguide is not a social tool, but it should consider the diversity of cultures of its users. Interface standards should guide its design to accommodate this.
Ec	**Accessing the SMARTguide** in practical laboratories, or time taken to download a SMARTguide and make it work on the chosen device. Power consumption, data used, downtime, access to a device.	**Access** to the SMARTguide uploaded to the LMS **require data**, while the downloaded version may be accessed directly with only the additional resources referenced requiring data. Downloading the SMARTguide requires access to data as well.	Downloading the SMARTguide on any student owned device is a frugal approach, incurring no data costs, but **taking up storage space.** Should the device be a mobile phone, a student may have to view the SMARTguide on a device with a larger screen.	With the intention to accommodate all students, SMARTguides should be compact to ensure it takes up little storage space and uses little data to download.
A	**Coordination of** SMARTguide **colours** – a theme per semester, preference to run the SMARTguide on a particular device. The beauty of device covers.	The **colourful interface**, the conciseness of the included information, and the interactive self-assessment activity are designed to afford a fun-activity.	A colourful and **playful environment** that guides learning.	The design intention of SMARTguides should be to guide learning in a way which is colourful, playful and fun.
J	Accessibility of SMARTguides – on the LMS, and a variety of devices. The SMARTguide should **address students' study needs**; it should also make students accountable for their own studies. – –	By definition a **SMARTguide guides self-directed learning**. It was designed with this notion in mind.	– –	A study guide is expected to form part of the material available with a subject module to be offered. A SMARTguide attempts to ensure that what is due for all is made available.

Aspect	EIT	EMC	ELI	Combined guideline
Et	**Multiple ways of reaching study units** via tabs, or chronologically using arrows. – –	The SMARTguide should **show students what is expected from them**, it should also create a learning environment conducive to prepare for classes.	A SMARTguide allows a **student to take responsibility for his/her own learning at his/her own pace**, taking the time necessary to master the outcomes.	By supplying an interactive instrument in the form of a SMARTguide, an attempt is made to go beyond the imperative of what is due.
Pi	Assumptions users need to make, which helps or blocks engagement, may be guided by the vision that underlies the design. Accommodation of brands: iPad tablet or smartphone, Android tablet or smartphone, memory stick, laptop, or personal computer.	The vision of the SMARTguide is to **afford students the opportunity to prepare for class in such a way that the class itself** may **add value to the learning experience.** The SMARTguide should support a shared goal to ensure that students obtain a sound knowledge and understanding of the subject module, it should allow a pass opportunity for the student and a good pass rate for the lecturer, and it should also support a vision of future job opportunities.	– –	The SMARTguide allows the lecturer to impress his/her vision on the students – to ensure students who passes, but also graduates, will make a significant contribution to the workplace.

The guidelines extracted from aspectual analysis of instructional design in the form of the SMARTguides are discussed. It is done with repercussions in mind, since these are instances where implications may be expected:

- An electronic guide should allow the inclusion of all the material necessary to guide the subject module (*quantitative*), while each page should convey coherent units of information – the size of a screen should be considered (*spatial*). Fluid movement between tabs, and units, expansion via Internet access to include supportive environments, and fluid access between sessions are a necessity (*kinematic*). All necessary material should be available in one place – the device used to access the material – this may require an active Internet link (*physical*). Only a limited number of facts should be represented per page, and a variety of visual material, engaging all the human senses will support learning (*organic*).
- Sensory stimulation may aid the learning process, therefore the use of colour and sound extend the vehicles introduced in the organic (*sensitive*). Throughout the SMARTguide, a similar layout highlighted with tabs – to allow individual access – that progress in a logical way, should be used to guide the learning of each study unit

(*logical*). This aspect retrocipates the special aspect since it builds on the formation of coherent units of information. The student should be guided to either progress through the material in the order it is presented, or to access material and be guided from general knowledge to detail (*formative*). Interface standards should guide its design to accommodate the diversity of the cultures of its users.

- As a lingual instrument, SMARTguides should display diverse representations which convey the same message (*lingual*). A SMARTguide should consider the diverse cultures of its users (social). SMARTguides should be compact to ensure it takes up little storage space and uses limited data to download it (*economic*). The design intention of SMARTguides should be to guide learning in a way which is colourful, playful and fun (*aesthetic*).
- A study guide is expected to form part of the material available with a subject module to be offered (*juridical*). SMARTguides should attempt to go beyond the imperative of due by supplying more ways to approach the subject material (*ethical*). This aspect retrocipates the quantitative, since an electronic guide does not have the pages limitation associated with a printed guide. The SMARTguide should impress the vision of the lecturer on students – to ensure students pass when meeting the desired level of competence, but also graduates who can make the intended contribution to the workplace (*pistic*).

7.4.2.2 Formative guidance – Videos

Regarding the world of engagement with meaningful content (EMC), the videos guide academic understanding regarding a particular challenging concept in SA&D. In Table 7.6 each of the aspectual engagements are firstly listed individually, and then merged to list a combined guideline. The phrases from each engagement that may contribute to the formulation of the combined guideline is shown in bold.

Table 7.6: Aspectual analysis of the Videos incorporated as formative guidance

Aspect	EIT	EMC	ELI	Combined guideline
Q	A **single concept** should be covered per video. Pixels. Number of downloadable devices.	Number of videos and number of videos per study unit should be sufficient to **cover challenging concepts**.	A balanced number of videos – only for the purpose of **directing challenging concepts** may enhance the reciprocal action between various ways of learning.	A video should cover a single concept. This allows for the creation of short videos. The combination of videos should address all challenging concepts.

Aspect	EIT	EMC	ELI	Combined guideline
Sp	The space a student is in when viewing a short video. Size of a video should allow for the LMS upload limitation of 50MB. Size of devices used to view videos.	Screen layout – available space per page should be utilised well, while allowing enough white space.	Videos are embedded in the SMARTguide, which may be downloaded onto any electronic device with access to video playing software.	Access to a simple video that shows clear images on the small screen of a mobile device, works best.
K	Flow of visual and auditory material to facilitate understanding. Moving the mouse, tilting the device, and utilising one's fingers to start, stop, fast forward, and rewind to view and repeat full videos or parts thereof.	Flow and order of topics should coincide with the topics covered in the module - among videos and within a video. Sections of a video, or the full video may be repeated more than once.	In the case where a student made the effort of downloading the SMARTguide carrying the videos onto his/her phone, not much movement is required to access it to watch a video when a particular concept is prepared and a corresponding video exists. Otherwise, access to the eFundi LMS is a pre-requisite.	Although a video is not interactive, a viewer has control to start and stop whenever the need arises. Sections of a video, or the full video may also be repeatedly, repeated. The coordination of the visual and auditory material is important, as is the logical flow of the presentation.
Ph	Emission of light and sound. Availability of a touch-screen, material the device is made of.	– –	A state of inertia, with little expenditure of energy, is sufficient to watch a video. A student working through a video may gain a better understanding of a concept by stopping, rewinding, and re-starting the video to watch a section multiple times, making notes, and comparing the video material to the text book explanation.	The auditory component as well as the presentation material should be clear, even on a mobile device – with a small screen.
O	Engaging the visual-aural-tactile senses with a screen, speakers, mouse/ keyboard/ touch-screen. Clear emissions from the screen and speakers.	Allowance for smaller learning sections as part of each study unit, to accommodate the short term memory of a student.	Sound, combined with visual material – applied in a small learning section context should be sympathetic to all that is biotic.	A short video, focusing on a singular outcome, best accommodates the short term memory of a student. The auditory component should be clear to allow for physical adjustments.

Aspect	EIT	EMC	ELI	Combined guideline
Se	Sensitivity of **mouse, keys, or the screen, movement** of the mouse. Seeing the screen and hearing the speakers.	The **use of colour and sound** to help students to recognize and identify important concepts. Motivating students to look at a difficult concept beyond the video being watched ("what can I do next to enhance my understanding?").	Should the use of a video enlighten a student's understanding of a challenging concept, the student may be left with a **feeling of accomplishment.**	Strong colours and a positive message that clearly conveys the purpose of a video will facilitate understanding, leaving students with a feeling of accomplishment.
Lo	The **effective use of icons, text and numbers** and how it is emphasized using colours. Ensuring a video download is completed to access it on the selected device.	Creating **awareness of difficult concepts** and how it may be practically implemented.	With a limited number of videos made available, the existence of a video may guide students towards **the importance of the concept** in relation to other material.	The logical progress of concepts addressed by videos may support the logical progress of a video, while the inclusion of a video on a topic may highlight the importance of that topic.
F	Facilitation of start, stop, fast forward, rewind to **view a video**, interrupt it, or repeat parts of it. A video does not show on my device (because a video player is not installed).	**Placing difficult concepts in context**, both with regards to the flow of study units and how a particular concept fits into a group project.	The intention is to **shape understanding** of concepts in the minds of students – when watching the videos.	Within a video references made to work already covered, future work, textbook references, and project work may shape the understanding of students regarding the topic under discussion.
Li	Guiding the student's understanding by using **visual representations, developing listening skills** – done in such a way that it supports students' studies in the subject modules. Content included per screen. Labelling of video to distinguish between the topics covered.	**Communication** from lecturer to student, through the meaning of icons and colours used. In most videos the explanation is interweaved with an example.	The focus of many of the **videos relay information** on drawing models which use symbols to represent information regarding particular aspects of the system under development.	A video is a visual instrument that is amended by the auditory. Communication occurs by means of more than one sense. The two sources should complement one another.

Aspect	EIT	EMC	ELI	Combined guideline
So	Assumptions shared between the video maker (lecturer) and the users (students) from **different cultures**; basic user interface standards implemented; conformance to NWU standards and guidelines. Technology is a status symbol.	– –	– –	In principle a video is not a social tool, but it may establish a connection between the lecturer and the student. In addition, material should consider the diversity of cultures of its users. Interface standards should guide its design.
Ec	**Accessing videos** from practical laboratories, or time taken to download videos and watch it on the chosen device. Power consumption, data used, downtime, access to a device.	**Access** to the videos uploaded to the LMS **require data**, while the downloaded version may be accessed without requiring data.	**Downloading** the videos on any student owned device is a frugal approach, incurring no data costs. Should the device be a mobile phone, a student may have to watch the video on a device with a larger screen.	With the intention to accommodate all students, videos should be compact to ensure it takes up little storage space and uses little data to download it.
A	Videos include hand-drawn models. **Colourful pens** are used to distinguish between steps. The beauty of device covers.	Videos include **live hand-drawn SA&D models** explained by the lecturer.	The **use of colour** may add to the appeal of the videos.	The design intention of a video should be to guide learning in a way which is colourful, playful and fun.
J	**Accessibility of videos** – on the LMS, and a variety of devices. The videos should aid students' understanding. – –	A student is afforded the opportunity to **spend as much or as little time as is necessary to watch a video** – until (s)he understands the concept. Videos may be watched with different purposes in mind; introducing the concept before class, understanding the concept – to effectively apply it to the group project, or preparing for assessment.	– –	In principle a video on a challenging concept allows a student to watch it before class, and/or after the concept was explained. It may also be watched more than once.

Aspect	EIT	EMC	ELI	Combined guideline
Et	There is allowance for videos to be accessed multiple times – when it is required, **creating a learning environment conducive for directing own learning** of students. – –	Included **videos are short** (rarely more than 10 minutes). It only addresses challenging concepts.	In essence a **video** has a built-in self-giving patience since **it allows a student to watch it any number of times** – until the concept explained is understood.	By supplying more ways to approach the subject material, videos go beyond the imperative of what is due.
Pi	Assumptions users need to make, helps or blocks engagement which may be **guided by the vision that underlies the design.** Accommodation of brands: iPad tablet or smartphone, Android tablet or smartphone, memory stick, laptop, or personal computer.	**Videos should support a shared goal** to ensure that students obtain a sound knowledge and understanding of the subject modules, it should allow a pass opportunity for the student and a good pass rate for the lecturer, and it should also support a vision of future job opportunities.	– –	A video create an opportunity for a student to learn and understand a challenging concept well. This may reflect in a student's marks, but also scaffolds a student's understanding of follow-up subjects, and support excellence in a career.

The guidelines extracted from aspectual analysis of instructional design in the form of the Videos are discussed. It is done with repercussions in mind, since these are instances where implications may be expected:

- Although a video may be of any length, in this context, it was decided that it should cover a single challenging concept and be of a short length (*quantitative*), the production of a video should consider the range of devices on which it may be accessed – especially the size of a screen should be considered (*spatial*). Someone viewing a video has control to start and stop it whenever the need arises. Although a video is a sequential tool, sections of a video, or the full video, may be repeated, multiple times (*kinematic*). All aspects of a video – auditory and visual – should be clear, even on smaller devices (*physical*). A short, singular outcome video should accommodate the human short term memory (*organic*).
- A message clearly conveying the purpose of a video may facilitate understanding (*sensitive*). A singular video should progress in a logical way, while the prerequisite knowledge to a video, covered in another video should be indicated (*logical*). Within a video references made to future work, work already covered, and other resources may shape the understanding of students regarding the topic under discussion (*formative*).

- Communication occurs by means of more than one sense, a video is a visual instrument that is amended by the auditory (*lingual*). A video should consider the diverse cultures of its users (*social*). Videos should be compact to ensure it takes up small amount of storage space and uses limited data to download (*economic*). The design intention of video production should be to convey content in a colourful, playful and fun way (*aesthetic*).
- A video may be watched repeatedly (*juridical*), while it forms part of a tool kit, it allows complementing ways to explain material (*ethical*). A video create an opportunity for a student to learn and understand a challenging concept well – to ensure that students passes when meeting the desired level of competence. In addition, it supports scaffolding of follow-up concepts, and supports excellence in a career, but also graduates who can make the intended contribution to the workplace (*pistic*).

7.4.2.3 Summative assessment – WhatsApp conversations

Regarding the world of engagement with meaningful content (EMC), the WhatsApp conversations facilitate knowledge building and making sense of material while preparing for assessment in the two subject modules under discussion. In Table 7.7 each of the aspectual engagements are firstly listed individually, and then merged to list a combined guideline. The phrases from each engagement that may contribute to the formulation of the combined guideline is shown in **bold**.

Table 7.7: Aspectual analysis of the WhatsApp group conversations

Aspect	EIT	EMC	ELI	Combined guideline
Q	**Number of participants** determines the size of group(s) because of application constraints; number of groups, number of questions with corresponding answers influence interactivity, pixels. Number of downloadable devices.	Throughout each year a **number of groups** are formed – for different purposes, such as the accommodation of a variety of MIMAs, class groups, and examination 2 (the group used for the first examination flows from the class groups).	**Number of messages** sent on each group. The number of participants may influence the height of activity. Guidance pertaining to the use of WhatsApp groups for learning may help to direct its use.	The size of a WhatsApp group determines the activity levels. The size of a group also has an influence on how messages facilitates understanding when questions are answered. Large groups may require the use of broadcasts, or the restriction of activity of all or some student members.

Aspect	EIT	EMC	ELI	Combined guideline
Sp	Screen layout. Size of messages and diagrams determine whether participants read and participate. The space a student is in when participating. Size of devices used to view messages.	With WhatsApp being a mobile application, screens are tiny by definition. A short message, intermingled with emoji to convey emotion, works best. Lately students successfully share PDF-files of books and notes, pictures of hand-drawn answers and short videos.	Mobile phones are intertwined with peoples' lives. Possibly more so in the case of students who may be far from home, are socially active, and in an IT educational environment – are dependent on their peers to complete projects.	MIMAs were developed to be used on mobile devices, therefore small logical units of information should be conveyed per message, taking screen size into consideration.
K	Order and flow of messages and the interweaving of different message strands may influence understanding. Moving the mouse, utilising one's fingers, tilting the device to enlarge pictures.	In the early stages of using MIMAs, the lecturer facilitated questioning. With time, students are determining their need for answers (or not). Selection, flow and order of topics and uses are determined by the body of students on the group. In some cases no answers to potential assessment questions are asked.	With mobile phones being small it fits into one's pocket and its battery is loaded while it lies on one's desk or bedside table; not much movement is required to access it to follow up on an incoming message.	When part of a WhatsApp group, busy times may be marked by more than one message stream. A recent feature – to refer back to a question (the quote-feature (➦)), or message stream helps to guide flow.
Ph	Emission of light and sound. Availability of a touch-screen, material the device is made of.	– –	A state of inertia, with little expenditure of energy, is sufficient to read a message, and send a response.	People determines the access to their phones by using its sound setting, or the mute function available on WhatsApp.
O	Engaging the visual-aural-tactile senses with a screen, speakers, mouse/ keyboard/ touch-screen. Clear emissions from the screen and speakers. Silencing incoming messages.	Interruption hinders study progress, but may also motivate much needed study breaks. The mute-group feature may be helpful. MIMAs allow students to obtain information just-in-time (as opposed to just-in-case), relating to the approach to knowledge acquisition many millennials have.	Muscles may be affected by typing, and much strain is placed on the user's eyes. Lately WhatsApp allows access to the application on any device, which may relieve strain with regard to typing and eyes.	Dependent on the physical, students should be made aware of technology features which may support their intentions – such as making time to focus on a task without interruptions.

Aspect	EIT	EMC	ELI	Combined guideline
Se	Sensitivity of **mouse, keys, or the screen, movement of the mouse.** Seeing the screen and hearing the speakers.	Use of **colour and sound** is limited, but text enhanced with ***bold*** and _*italics*_, emoji (), voice notes, pictures and short videos are effectively used in this context. The format motivates students to engage in answering a question.	Anxiety may be a feeling users entertain should an incoming message be experienced as interrupting other important work. Frustration may be experienced should a question not be answered immediately. However, in many cases, bantering among peers may leave users feeling happy.	Sensory stimulation may aid the learning process. Using the variety regarding presentation of material may aid understanding.
Lo	Explaining concepts logically is **supported by the use of emphasis, and the inclusion of emoji, voice notes, and pictures** – in addition to only using text. Installing WhatsApp to one's smartphone and arranging to be added to the group ensures access.	Creating awareness of potential questions in a test or examination – when a question is asked. **Linking answers to questions** on a busy chat using the quote-feature (➦) allows more than one concurrent conversation.	Distinguish between MIMAs being helpful while studying for a test or examination, and it being a tool to enhance one's social life is important. Using a **WhatsApp group while studying** to get an answer to a question or clarity on something that is not understood, may support study progress.	A logical explanation in a MIMA context is dependent on flow. Therefore this aspect retrocipate to the kinaesthetic, where it may be necessary to refer back to a previous post to ensure that the reader is guided with regard to which stream of messages is relevant.
F	The **structuring of sentences along with the inclusion of diagrams** may effectively direct questions-and-answers. A smartphone device is sufficient to accommodate WhatsApp.	**Students** determine their progress through **self-directed learning and self-determine** when **progress** is hampered and a question manifests. Such an occurrence may influence the disposition of peers.	The **WhatsApp conversations** may **distract** a student from studying, but it may also **impress** on an individual that peers are busy preparing themselves for an assessment.	A WhatsApp group focused on preparation assessment may have an influence on the group regarding how well they progress with their preparation. Questions posted on a particular study unit gives an indication as to how far peers have progressed.
Li	**Text** enhanced with bold and italics, **voice notes**, **emoji**, and **pictures conveys messages** on a mobile device. Text labelling of a group (with an accompanying icon) distinguishes chats.	**Direct communication** between student-and-lecturer, and student-and-student. Answers are not supplied by the lecturer immediately – to allow peers the opportunity of supplying an answer. In some instances a student would specifically request an answer from the lecturer.	**Conversations depend on the lingual** whether it is text, emoji's, pictures, voice messages, or videos. In all cases in this context, less is more.	A WhatsApp group is a lingual resource, which allows the acquisition of knowledge through the lingual.

Aspect	EIT	EMC	ELI	Combined guideline
So	**Adherence to social conventions**, as well as conformance to NWU standards and guidelines. Technology is a status symbol.	**Build relationships** (lecturer-student, and student-student). Incorporating elements of fun, sharing feelings and knowledge, and constructing meaning in the context of SA&D. When conformance issues are encountered, the group administrator (lecturer) addresses it.	**Students may experience a sense of responsibility** – they need to spend time in preparing for a test, not to disappoint those depending on them to perform well (parents, friends, peers, and the lecturer).	MIMAs address social needs. Sensitivity towards culture diversity and social conventions are important. It may assist in building relationships.
Ec	**Access to a personal mobile device** is paramount. Clarity of pictures messaged may affect understanding. Power consumption, data used, downtime, access to a smartphone.	Using a MIMA such as WhatsApp interactively, requires data. **Data usage is conservative** when only text messages are sent. To curb the use of excessive data, correct settings prevent the download of images and videos.	In some cases students may experience the WhatsApp group formed to assist with studies as a waste of time. This may be due to a lot of unrelated messages being posted. Others may find it useful since information is obtained through MIMAs instead of other more expensive ways.	Not all students have access to a mobile device, and specifically a smartphone. Access to Wi-Fi or buying data may be a challenge, even when a student has access to a device.
A	**WhatsApp allows for the sending of text, voice notes, hand-drawn and other pictures, and videos.** The beauty of device covers.	**Students enjoy the use of MIMAs.** Especially when they learn to know and trust one another, they build rapport and easily mingle jokes with the serious stuff to address stressful situations.	**A sense of harmony and a fun environment engage students.**	The intended use of the WhatsApp groups should be to guide learning in a way which is colourful, playful and fun.
J	A WhatsApp group may **address actual student questions**, but should also **appeal to their responsibility** to direct their own studies and understanding. – –	A student may choose to be part of the yearly created groups, or not. **The value a student gets from the group is encapsulated in his/her own participation**. The new unsent-messages feature (delete for everyone) may assist in addressing contentious topics after it is sent.	A student may feel obliged to answer the question posed by a peer. Such an action may **help** both **students to understand the work better.** It may also take much time to formulate answers and therefore distract the student helping others from his/her own studies.	A MIMA group is not expected to form part of an academic offering, but when such a group is formed its intention is to ensure that what is due for all is made available.

Aspect	EIT	EMC	ELI	Combined guideline
Et	**Students get an indication of how well they are progressing with their preparation**, they may obtain answers to questions, and they may answer questions from peers. – –	**Answering the questions of peers is an act of generosity**, but at the same time, it affords a deeper understanding of what is explained.	**A student helping peers is an act of self-giving**, allowing others to benefit from one's own knowledge and contributing to the common good.	By forming a WhatsApp group, an attempt is made to go beyond the imperative of what is due.
Pi	Assumptions users need to make which helps or blocks engagement may be **guided by the vision that underlies the design.** Accommodation of brands: iPad tablet or smartphone, Android tablet or smartphone, memory stick, laptop, or personal computer.	**WhatsApp should support a shared goal** to ensure that students obtain a sound knowledge and understanding of the subject modules, it should allow a pass opportunity for the student and a good pass rate for the lecturer, and it should also support a vision of future job opportunities.	**The trust people place in a student (juridical) impels them to use their resources to its full extent**. This may include the use of MIMAs, or not.	A MIMA group gives students direct access to their lecturer and peers. It is up to an individual to choose whether (s)he wants to actively participate, or passively. From the lecturer's perspective, misunderstanding may be addressed immediately.

The guidelines extracted from aspectual analysis of instructional design in the form of the WhatsApp conversations are discussed. It is done with repercussions in mind, since these are instances where implications may be expected:

- Although the number of participants currently may not exceed 250 members, a group in excess of 100 members, needs to be carefully managed to keep conversations focused on the purpose of the group. In addition, the number of groups may help to preserve focus, and the number of messages contribute to the success of the artefact's use (*quantitative*). The size of a device, the space the student is in, and the physical support in the learning context a participant experience, influence the effectiveness of the tool (*spatial*). A Smartphone is easy to carry around, with its size being small. Also, the order and flow of messages need to be managed to facilitate understanding. Interweaving messages on multiple topics make it challenging to have a focused conversation in a busy group. The newly added quote-feature (↩), helps participants to manage this (*kinematic*). The quote-feature anticipates the logical aspect since it allows participants to logically follow an argument. Little physical impact is exerted when using WhatsApp as tool (*physical*). Using a small device for reading and typing may put strain on one's eyes and muscles, while studying incoming messages may interrupt concentration (*organic*).

- Although interruptions caused by a busy group (*sensitive*), may be frustrating, WhatsApp has a built-in feature that allows a user to mute a group from time to time, or permanently. Instances may occur where a particular question is not answered by peers or the lecturer, especially during busy periods – which may leave the student dejected, but receiving an immediate answer is motivating, and the use of a MIMA may help students with limited time to prepare for assessment, to know what to focus on in a short span of time (*logical*). WhatsApp allows students to direct their own learning. When a question is asked, an answer is expected. This is not necessarily the best approach in such circumstances, since the thought processes required to obtain an answer may be missing (*formative*). The formative aspect retrocipates the sensitive, where interruptions should preferably be managed.
- Although multimedia options available on an electronic mail platform, is currently also available on a MIMA, the devices are typically much smaller than a computer, making communication slightly more challenging. The fact that a smartphone is carried around, allows for immediate communication, which makes up for the fact that the device is smaller (*lingual*). In an educational context IT students need to form project and work groups, which is typically formed among friends – should the students be in a position to form the group themselves – which supports learning in a social context *(social*). Most students enjoy using a Smartphone, they view it as a status symbol. Participation on a MIMA does incur a cost in terms of a mobile device and the data required to message, but this may be small when compared to other forms of interaction *(economic)*. The communication afforded by a mobile app such as WhatsApp creates harmony and enjoyment (*aesthetic*).
- Regarding higher-order aspects, a WhatsApp-group created for assessment preparation may address legitimate questions, while also facilitating and directing learning (*juridical*). Academically stronger students with confidence in their abilities are more likely to answer questions, while a more social student may spend too much time on WhatsApp. Interruptions are the underlying challenge and therefore the juridical retrocipates the sensitive. A WhatsApp group afford students the opportunity to track progress with regard to peers while also assisting peers (*ethical*). Assistance provided may assist peers, but also improve the understanding of the person providing answers and facilitating the gaining of insight regarding subject knowledge and the development of a potential future career (*pistic*).

7.4.3 The applicability of AEF to this study

Building on Section 7.4.2, this section consolidates development by incorporating the combined guidelines, and showing how the abstracted guidelines are extracted.

With the purpose to show the process which was followed to obtain the abstracted guideline in Table 7.9, Table 7.8 is included. The latter table reflects the combined guideline columns from Table 7.5 through to Table 7.7, and adds a column which extracts an abstracted guideline per modality. The phrases from each engagement that may contribute to the formulation of the guideline, is shown in **bold**.

Table 7.8: Aspectual analysis of the SMARTguides, Videos, and WhatsApp groups used to extract abstracted guidelines

	Combined guideline			
Aspect	SMARTguide	Video	WhatsApp	Abstracted guideline
Q	An electronic guide should allow the inclusion of **all the material necessary** to guide the subject module.	**A video should cover a single concept.** This allows for the creation of short videos. The number of videos should address all challenging concepts.	**The size of a WhatsApp group determines the activity levels**. The size of a group also has an influence on how messages facilitates understanding when questions are answered. Large groups may require the use of broadcasts, or the restriction of activity of all or some student members.	Only the MIMA groups have a size limitation in terms of the members accommodated. In all focal points a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number.
Sp	**Logical units of information** should be conveyed per page, taking screen size into consideration.	**Access to a simple video** that shows clear images on the small screen of a mobile device, works best.	MIMAs were developed to be used on mobile devices, therefore **small logical units of information** should be conveyed per message, taking screen size into consideration.	All types of devices should be considered, but special attention should be given to mobile devices with its small screens, making it imperative to compile compact chunks of information.
K	**Electronic guides should be interactive**, while fluid movement between pages/tabs, and units, expansion via Internet access to include supportive environments (such as eFundi), and fluid access between sessions are a necessity.	Although a video is not interactive, **a viewer has control to start and stop** whenever the need arises. Sections of a video, or the full video may also be repeatedly, repeated. The coordination of the visual and auditory material is important, as is the logical flow of the presentation.	When part of a WhatsApp group, **busy times may be marked by more than one message stream**. A recent feature – to refer back to a question (the quote-feature (➦)), or message stream helps to guide flow.	Interactivity should be applied in a way which a specific tool allows. Effort should be made to ensure that fluid movement between components are established.

Combined guideline				
Aspect	SMARTguide	Video	WhatsApp	Abstracted guideline
Ph	Electronic guides should allow access to all the necessary material in one place – the device used to access the material. Such access may require an active Internet link.	The auditory component as well as the presentation material should be clear, even on a mobile device – with a small screen.	People determines the access to their phones by using its sound setting, or the mute function available on WhatsApp.	Tools should support the visual, as well as the auditory by presenting clear displays and sound.
O	Only a small number of facts should be represented per page (a maximum of seven facts would support short term memory), a variety of visual material, engaging all the human senses will support learning.	A short video, focusing on a singular outcome, best accommodates the short term memory of a student. The auditory component should be clear to allow for physical adjustments.	Dependent on the physical, students should be made aware of technology features which may support their intentions – such as making time to focus on a task without interruptions.	Units of material should be compact, and a limited number of facts should be conveyed in an engaging way.
Se	Sensory stimulation may aid the learning process. The use of colour and sound extend the vehicles introduced in the preceding modal aspect (organic).	Strong colours and a positive message that clearly conveys the purpose of a video will facilitate understanding, leaving students with a feeling of accomplishment.	Sensory stimulation may aid the learning process. Using the variety regarding presentation of material may aid understanding.	Colour and sound, combined with a strong message which clearly conveys the purpose of a concept may facilitate understanding.
Lo	A similar layout highlighted with tabs – to allow individual access – that progress in a logical way, should be used to guide the learning of each study unit.	The logical progress of concepts addressed by videos may support the logical progress of a video, while the inclusion of a video on a topic may highlight the importance of that topic.	A logical explanation in a MIMA context is dependent on flow. Therefore this aspect retrocipate to the kinaesthetic, where it may be necessary to refer back to a previous post to ensure that the reader is guided with regard to which stream of messages is relevant.	The coordination of tools should support the logical progression of the presentation of material.
F	Building on the preceding modal aspect (logical), the formative has the aim to guide the student to either progress through the material, or to access material and be guided from general knowledge to detail. The latter may be just-in-time material needed to perform a task, such as completing an assignment.	Within a video references made to work already covered, future work, textbook references, and project work may shape the understanding of students regarding the topic under discussion.	A WhatsApp group focused on preparation assessment may have an influence on the group regarding how well they progress with their preparation. Questions posted on a particular study unit gives an indication as to how far peers have progressed.	When possible, the integration of tools may support the guidance which should be provided by any educational technology tool.

Combined guideline				
Aspect	SMARTguide	Video	WhatsApp	Abstracted guideline
Li	A SMARTguide is a lingual resource, which allows the acquisition of knowledge through the lingual. Therefore information presented may be diverse, but should convey the same message.	A video is a visual instrument that is amended by the auditory. Communication occurs by means of more than one sense. The two sources should complement one another.	A WhatsApp group is a lingual resource, which allows the acquisition of knowledge through the lingual.	In the case of all three focal points, engagement with content relies on the lingual. This may be supported by other mechanisms, but care should be taken to convey the same message.
So	In principle, a SMARTguide is not a social tool, but it should consider the diversity of cultures of its users. Interface standards should guide its design to accommodate this.	In principle a video is not a social tool, but it may establish a connection between the lecturer and the student. In addition, material should consider the diversity of cultures of its users. Interface standards should guide its design.	MIMAs address social needs. Sensitivity towards culture diversity and social conventions are important. It may assist in building relationships.	Of the three focal points, only the WhatsApp group supports social interaction, but the three focal points should consider the diversity of cultures of its users to ensure widespread use.
Ec	With the intention to accommodate all students, SMARTguides should be compact to ensure it takes up little storage space and uses little data to download.	With the intention to accommodate all students, videos should be compact to ensure it takes up little storage space and uses little data to download it.	Not all students have access to a mobile device, and specifically a smartphone. Access to Wi-Fi or buying data may be a challenge, even when a student has access to a device.	Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.
A	The design intention of SMARTguides should be to guide learning in a way which is colourful, playful and fun.	The design intention of a video should be to guide learning in a way which is colourful, playful and fun.	The intended use of the WhatsApp groups should be to guide learning in a way which is colourful, playful and fun.	Technology tools should be designed in a way which is aesthetically pleasing. It should involve the user in a colourful, playful and fun environment.
J	A study guide is expected to form part of the material available with a subject module to be offered. A SMARTguide attempts to ensure that what is due for all is made available.	In principle a video on a challenging concept allows a student to watch it before class, and/or after the concept was explained. It may be watched more than once as well.	A MIMA group is not expected to form part of an academic offering, but when such a group is formed its intention is to ensure that what is due for all is made available.	An educational tool should fulfil its purpose and provide the guidance, information, or clarity accordingly to ensure that what is due for all is made available.
Et	By supplying an interactive instrument in the form of a SMARTguide, an attempt is made to go beyond the imperative of what is due.	By supplying more ways to approach the subject material, videos go beyond the imperative of what is due.	By forming a WhatsApp group, an attempt is made to go beyond the imperative of what is due.	The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.

Combined guideline				
Aspect	SMARTguide	Video	WhatsApp	Abstracted guideline
Pi	The SMARTguide allows the lecturer to impress his/her vision on the students – to ensure students who passes, but also graduates will make a contribution to the workplace.	A video create an opportunity for a student to learn and understand a challenging concept well. This may reflect in a student's marks, but also scaffolds a student's understanding of follow-up subjects, and support excellence in a career.	A MIMA group gives students direct access to their lecturer and peers. It is up to an individual to choose whether (s)he wants to actively participate, or passively. From the lecturer's perspective, misunderstanding may be addressed immediately.	The focal points facilitate in-depth learning which should effect students beyond the classroom.

With the abstract guidelines extracted, aspectual analysis is performed next.

7.4.3.1 Aspectual analysis

With AEF addressing the integration of technology, content, and pedagogy, as implemented in the context of this study, was discussed in Section 7.3, is used to guide the identification of guidelines which are of value to the research. The general nature of the three focal points of instructional design, formative guidance and summative assessment in relation to AEF is the focus. Table 7.9 simplifies Table 7.8 and lists only the abstracted guideline per modality.

Table 7.9: Abstracted guidelines, obtained from the combined guidelines for three focal points, indicated per aspect

Aspect	Abstracted guideline
Q	Only the MIMA groups have a size limitation in terms of the members accommodated. In all focal points a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number.
Sp	All types of devices should be considered, but special attention should be given to mobile devices with its small screens, making it imperative to compile compact chunks of information.
K	Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement between components are established.
Ph	Tools should support the visual, as well as the auditory by presenting clear displays and sound.
O	Units of material should be compact, and a limited number of facts should be conveyed in an engaging way.
Se	Colour and sound, combined with a strong message which clearly conveys the purpose of a concept may facilitate understanding.
Lo	The coordination of tools should support the logical progression of the presentation of material.
F	When possible, the integration of tools may support the guidance which should be provided by any educational technology tool.
Li	In the case of all three focal points, engagement with content relies on the lingual. This may be supported by other mechanisms, but care should be taken to convey the same message.
So	Of the three focal points, only the WhatsApp group supports social interaction, but the three focal points should consider the diversity of cultures of its users to ensure widespread use.

Aspect	Abstracted guideline
Ec	Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.
A	Technology tools should be designed in a way which is aesthetically pleasing. It should involve the user in a colourful, playful and fun environment.
J	An educational tool should fulfil its purpose and provide the guidance, information, or clarity accordingly to ensure that what is due for all is made available.
Et	The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.
Pi	The focal points facilitate in-depth learning which should effect students beyond the classroom.

The benefits of aspectual analysis include the separation of issues facilitated by the modal aspects, and the opening up of our thinking regarding results obtained from analysis – when making logical deductions (Basden, 2018:192). The purpose of aspectual analysis is to identify the possible ways in which the use of a computer may be meaningful and how we are impacted (Basden, 2008:127). Aspectual analysis helps us to evaluate a situation through aspects in their representation-exclusion, balance-imbalance relationships (Basden, 2008:155). This has been done in Section 7.4 and culminated in aspects not expressed in the three focal points, as is shown in Table 7.11 in the next section.

The aim is to improve quality (Basden, 2008:253). Basden (2018:190) posits that, the more aspects expressed in a technological tool, the more satisfying it is, and the more useful it becomes. By implication, not all aspects would necessarily be expressed in a particular tool, although the aim should be to express as many as possible. Therefore, since each Dooyeweerdian aspect proposes laws, norms, and possibilities, distinct from all other aspects – designers should encapsulate these in applications, more so in serious applications, such as those used in educational settings. In educational software tools, the more aspects of content included for the purpose of engagement, the closer it gets to a real-world situation, and more robust, it becomes. These are the aspects that may be prompted when the guidelines are verified and refined in the empirical context.

7.5 CONCEPTUAL GUIDELINES

At the start of this chapter, the aim was to compile conceptual guidelines for the use of technology, by incorporating the three focal points of this study (M_{PS}). The methodological processes (M_R), involved using the AEF (M_R), developed by Basden and based on the work of Dooyeweerd (F) to analyse the HCI foci derived from extant literature. This highlighted gaps in the derived HCI foci. In addition, the three focal points of SMARTguides, Videos, and WhatsApp, were also analysed. Table 7.10 lists the conceptual guidelines – to be verified and refined in Chapter 8.

Table 7.10: Conceptual guidelines, viewed in the context of the three focal points, and mapped to the derived HCI foci

No.	Derived HCI focus	Conceptual guideline
1	Consistency and familiarity facilitate learning	K: Interactivity should be applied in a way which a specific tool allows. Effort should be made to ensure that fluid movement between components are established.
2	Guide users by using physical and logical constraints	Q: Only the MIMA groups have a size limitation in terms of the members accommodated. In all focal points a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number.
		Sp: All types of devices should be considered, but special attention should be given to mobile devices with its small screens, making it imperative to compile compact chunks of information.
		O: Units of material should be compact, and a limited number of facts should be conveyed in an engaging way.
		F: When possible, the integration of tools may support the guidance which should be provided by any educational technology tool.
		Ec: Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.
		J: An educational tool should fulfil its purpose and provide the guidance, information, or clarity accordingly to ensure that what is due for all is made available.
3	Flexibility allows for effective use	So: Of the three focal points, only the WhatsApp group supports social interaction, but the three focal points should consider the diversity of cultures of its users to ensure widespread use.
		Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.
4	Prevent mistakes, or allow for its clear identification	Li: In the case of all three focal points, engagement with content relies on the lingual. This may be supported by other mechanisms, but care should be taken to convey the same message.
		A: Technology tools should be designed in a way which is aesthetically pleasing. It should involve the user in a colourful, playful and fun environment.
5	Allow for recovery from mistakes by returning to a previous state	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.
6	Capabilities performed according to user intentions	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.
		Pi: The focal points facilitate in-depth learning which should affect students beyond the classroom.
7	Multithreading supports simultaneous tasks,	Ph: Tools should support the visual, as well as the auditory by presenting clear displays and sound.

No.	Derived HCI focus	Conceptual guideline
	multimodal dialogue includes multiple human senses	Se: Colour and sound, combined with a strong message which clearly conveys the purpose of a concept may facilitate understanding.
		Lo: The coordination of tools should support the logical progression of the presentation of material.
8	Timely communication of task status	K: Interactivity should be applied in a way which a specific tool allows. Effort should be made to ensure that fluid movement between components are established.
		Li: In the case of all three focal points, engagement with content relies on the lingual. This may be supported by other mechanisms, but care should be taken to convey the same message.

In Section 7.4.1, the HCI foci derived from literature (Chapter 4, Table 4.3), was subjected to an aspectual checklist (Table 7.4). In Table 7.11, the abstracted guidelines, compiled in Table 7.9, is mapped to the original aspectual checklist to identify aspects that are expressed through the derived HCI foci (⊗). The original mapping of Table 7.4 is retained to allow comparison. As a reminder; the use of an “x” indicates applicability in the mind of the researcher, with an “**X**” distinguishing qualifying modality, and the case of HCI focus 7 distinguishes “*multithreading*”, where the status quo is applied, and “*multimodal* dialogue” where a curly “***X***/ *x*” is used to distinguish between the qualifying modality and applicability.

Table 7.11: Checklist: the abstracted guidelines, mapped to the derived HCI foci

Pos	Derived HCI focus	Q	SP	K	Ph	O	Se	Lo	F	Li	So	Ec	A	J	Et	Pi
1	Consistency and familiarity facilitate learning.			x ⊗				X	x							
2	Guide users by using physical and logical constraints.	⊗	⊗	x		⊗			X ⊗			⊗		X ⊗		
3	Flexibility allows for effective use.			⊗			x		X		⊗			x		
4	Prevent mistakes, or allow for its clear identification.									⊗		x	X ⊗	x		
5	Allow for recovery from mistakes by returning to a previous state.			x			X								X ⊗	
6	Capabilities performed according to user intentions.						x		X	x					⊗	⊗
7	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses.		***X***		⊗	x	X ⊗	⊗						*x*	x	

Pos	Derived HCI focus	Q	SP	K	Ph	O	Se	Lo	F	Li	So	Ec	A	J	Et	Pi
8	Timely communication of task status.			⊗					x	X ⊗			x			

From the extension of the aspectual checklist above it is shown that the derived HCI foci are represented as qualifying aspect, applicability in the mind of the researcher, or expression gained from the process of extraction of guidelines. It is important to note that nine non-represented areas of the HCI foci gaps were intuitively identified at the start of Section 7.4.1 (quantitative, kinematic, physical, organic, social, economic, juridical, ethical and pistic). It was then narrowed down to four aspectual modality gaps towards the end of Section 7.4.1 when the derived foci has been applied (quantitative, physical, social, and pistic), has been filled. Therefore, by identifying guidelines in the use of the three focal points as is shown in Table 7.9, no explicit gap is contended for. The link between preceding tables above and Table 7.11 lies in the modalities, listed vertically in the former table and horizontally in the latter table.

7.6 MAKE INTERVIEW TECHNIQUE IN SUPPORT OF AEF

Winfield (2000) developed the interview technique to elicit knowledge that people already acquired, namely MAKE. This technique was inspired by Dooyeweerdian philosophy (Basden, 2008:256). The technique is summarised in Table 7.12.

Table 7.12: MAKE as developed by Winfield (2000:286) to investigate the knowledge people have developed on a topic

Step	Step explained	Notes
1	Introduction: briefly explain the 15 modal aspects of Dooyeweerd to the participant. Have an aspectual template[a] available for reference purposes.	i. It may be useful to eliminate the first five modal aspects which have determinative functioning and therefore allows limited freedom of response, including the quantitative, spatial, kinematic, physical and organic aspects (Kane, 2005:108). ii. This leaves the interviewer with the: sensitive, analytical, formative, lingual, social, economic, aesthetic, juridical, ethical, and faith aspects to work with. They allow freedom of response – within the laws of the aspect or by going against the laws of the aspect. iii. It may be helpful to include pictures to represent each aspect.
2	Start with a statement of requirements[b]	
3	Question the participant: apply the aspectual template to the statement of requirements and identify the important aspects.	

Repeat for each relevant or important aspect	1	Through questioning, isolate one of the aspects identified in STEP 3 and specify laws, axioms, data, definitions and constraints that apply within it to the domain in question.	
	2	Through questioning, identify as many concepts[c] as possible that lie in this aspect.	i. Interviewer may need to check whether the concepts[c] fall in the correct aspect.
	3	Through questioning, apply Low Level Abstraction[d] to expand on each concept that possibly needs exploding. This may identify new concepts and highlight the links between them.	
4		Revert back to the aspectual template and identify any new aspect(s) that may apply to the concepts already specified. Attempt to build bridges between concepts and aspects.	i. An aspectual map[e] can aid this step.

Explanation of terms applicable to MAKE:

a. Aspectual template: a printed list of aspects for reference purposes.
b. Statement of requirements: the focus of the information to be elicited from participants.
c. Concepts: examples from the environment in question - from the participant's perspective.
d. Low Level Abstraction: a concept developed by Winfield (2000) from Clouser (1991); it is applied to each concept where one may abstract properties of a thing (colour, weight, cost of a computer), but these properties are still of the thing (Basden, 2008:99, 254).
e. Aspectual map: a drawing representing the ten modal aspects, each with one or more concepts included, and an indication of how they are linked to one another.

Characteristics of MAKE include the following: it facilitates a broad knowledge elicitation, it supports the elicitation of (some types of) knowledge, it allows knowledge as multiple views, it helps the expert to reflect, and it educes facts fundamental to the knowledge domain (Winfield, 2000:230).

Also, MAKE confirms the following (Basden, 2008:256); knowledge on applications is multi-aspectual, aspects are distinct and therefore thought about deliberately, it may be expected that most aspects are relevant, each aspect allows for associated concepts, known laws, axioms and constraints, knowledge on aspects are connected, and kernel meanings of aspects may be understood intuitively.

A number of researchers implemented the MAKE interview technique:

- Winfield's MAKE was developed to study expertise. He would start with the aspects most important to the participant and then prompt the identification of issues meaningful in those aspects. He would then plot their relation as an aspectual map, a box-and-arrows diagram. With issues linked to other aspects emerging, their meaning is explained until all aspects the participant finds meaningful have been addressed. It was found that almost every aspect was covered using this method, with participants being surprised at their rich expertise (Basden, 2018:103).

- Kane's MAIT was developed when she found MAKE to be dependent on conceptual thinking for the purpose of studying aspirations, hopes and concerns of mature students regarding an anticipated experience (Basden, 2018:103). In her endeavour to interview, Kane (2005) built on the work of Winfield. Characteristics of MAIT include: supporting the participant in providing a rich content of information, helping the interviewer to avoid dominating the interview situation in both the environment and in the interview technique, allowing a wide range of aspectual referencing of information to be gained, allowing everyday life experiences to be seen as relevant and important, avoiding a reductionist pattern of data-collection, and gathering information with self-reflection upon the individual's meaning (Kane, 2005:255). Also, MAIT confirms the following: a multi-aspectual interview format situates control with the participant, aspects may provide a structure in designing interview questions, participants of different educational levels quickly form an intuitive understanding of the modal aspects, aspects are irreducible, which stresses the importance of each, aspects are interrelated which allows relationships to be made as and when the participant sees fit to do so, aspects are interdependent, allowing a holistic approach to information gathering as comments, relationships and narratives prevent reductionism and allow a rich content of information (Kane, 2005:228).
- Both MAKE and MAIT guided Ahmad in her study (Ahmad, 2013:84). It attended to everyday issues that affect the success or quality associated with mandatory IS use. With this approach she considered "*the user's everyday perspective rather than that of management, IT suppliers or researchers*" (Ahmad & Basden, 2013). In her empirical research, everyday use has been applied as qualitative analysis method enriched with Dooyeweerd's aspects (Ahmad & Basden, 2011). Her approach differed in two distinct ways from MAKE and MAIT:
  - o She planned to start her interviews with *categorised questions* with a focus on the formative or social aspects rather than all the fifteen aspects.
  - o In line with Winfield (2000) and Kane (2005), a list of aspects were introduced to the first participant. When she looked stunned on presentation of the list, the approach was changed, so that *participants were not introduced to aspects, it was kept in mind by the researcher only* (Ahmad, 2013:103).

The benefits observed through the use of MAKE are threefold: discernment and conversation is facilitated by the aspects' intuitive nature which participants could interpret freely; tacit knowledge that is hidden because it is perceived as self-evident is elicited; and the use of aspects in interviews heightened awareness and prompted participants to table issues normally avoided because it is perceived to be trivial, such as one's feelings, or it is embarrassing to address, such as money (Basden, 2018:104). It affords richer information, and a broader perspective.

Therefore the main purpose for utilising the aspects of Dooyeweerd, is to stimulate communication about things that people normally do not mention, for reasons such as embarrassment, privacy or triviality. ***Therefore, the interpretation that the participant attaches to an aspect is accepted and not criticised.*** Although it is anticipated that MAKE will work well for obtaining information from students who have completed the SA&D subject modules, it is anticipated that it may be necessary to guide them through prompts compiled from the conceptual guidelines as developed by the researcher to enable its verification and refinement. These students, who have passed the two subject modules under discussion, are using the knowledge gained in subsequent subject modules in their course, as well as beyond this – in a work environment. They should therefore have a clear idea of what they know, how much value the information has in their third year and beyond, and whether they think the knowledge would be helpful in a future job. These students should also have a clear idea whether SA&D is what they want to do in a future career, or whether they are utilising the knowledge they gained, while already working. In essence, they reflect on the "*what is*" of SA&D, and not "*what should be*".

Comparing this study with that of Kane (2005), who developed MAIT; she accessed mature students as participants, while this study would need to include first year students coming from a disadvantaged background, lacking maturity.

The MAKE interview technique will be utilised to interview alumni students of the course. The focus will be on former students who completed the course modules of SA&D and are working in the IS industry. These participants will be requested to analyse the artefact that they used when doing the subject modules before an interview commences.

The use of the MAKE may facilitate the to-and-fro discourse between the lecturer and the students in a formal way, while the underlying 15 modal aspects should ensure that all aspects of the intervention are taken into consideration. It is possible that aspects identified as not present in the study may guide the research with regards to how gaps indicated by missing or slightly represented aspects may be filled.

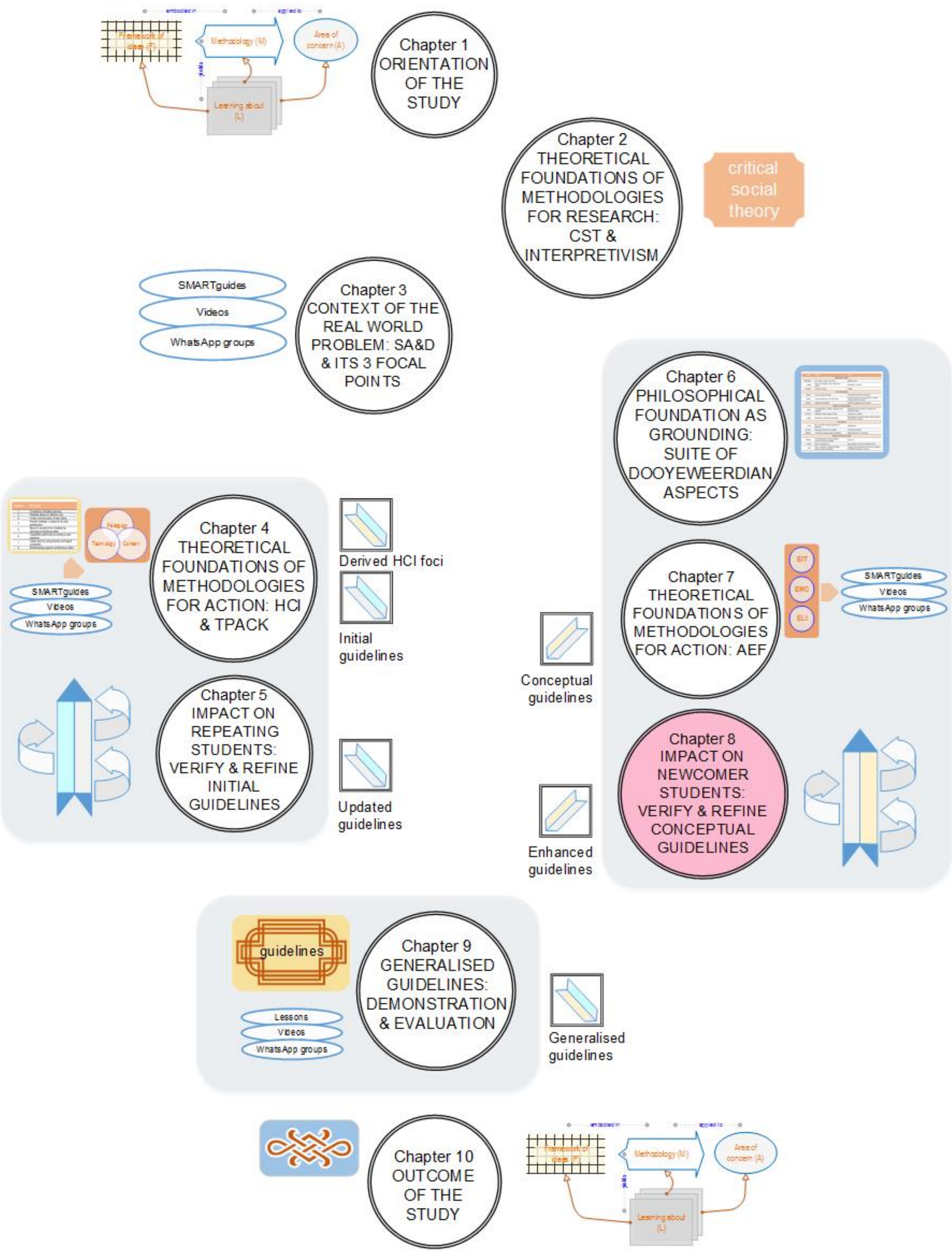
7.7 SUMMARY

In fulfilment of this study, which is to gain an understanding of the use of technology in higher education and to develop guidelines for the use of technology, based on an understanding of HCI principles – from a Dooyeweerdian perspective, this chapter addressed the third theoretical objective (T03), namely to investigate the AEF developed by Andrew Basden (2018), whose work is based on the work of Dooyeweerd. It entails the use of a framework for understanding in a technological context. This is a valuable contribution in the context of this study with its purpose to scrutinise HCI principles prevalent to the user interface.

Basden (2008) applied Dooyeweerd's philosophy with the aim to develop frameworks to enable understanding; the framework on HUC (renamed AEF), was investigated to be used in this study. The three separate areas of human functioning as suggested by Basden's generally applicable framework derived from philosophy, include EIT (interaction with an electronic device operating an artefact is paramount), EMC (interaction takes place with something that is stored on the memory of the electronic device), and ELI (interaction may or may not be with an electronic device). Practical devices for the analysis of data is applied to the three focal points of this study to extract conceptual guidelines. An interview technique that is based on the suite of Dooyeweerdian aspects has been introduced to be utilised when interviewing participants. The MAKE interview technique was designed to elicit an understanding regarding knowledge gained, and to obtain a rich perspective from participants (Winfield, 2000).

In the subsequent chapter, the suggested framework is implemented and tested in the context of IS, and specifically using technology to teach a technological subject, namely SA&D. The purpose is to scrutinise the guidelines prevalent to the user interface.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



8 IMPACT ON NEWCOMER STUDENTS: VERIFY & REFINE CONCEPTUAL GUIDELINES

8.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education, based on human computer interaction principles, from a Dooyeweerdian perspective.

In order to achieve this primary objective, this chapter addresses the second empirical objective (E02), namely to apply action research as five-step method to guide the verification of the conceptual guidelines obtained from the previous chapter – with the overarching purpose to improve the student experience, and the focus on students' emancipation to allow them to reach their full potential. The three focal points of instructional design, formative guidance, and summative assessment, again form part of this action research cycle. This evaluation is guided by the derived human computer interaction foci and the aspectual engagements framework studied in the previous chapter. The conceptual guidelines are verified and refined to obtain enhanced aspectual engagements framework guidelines.

In the subsequent sections, the focus of this chapter is firstly on the elements which are relevant to this study, and specifically this chapter (§8.2). The action research cycle with its background (§8.3) and five steps of diagnosis (§8.4), planning for action (§8.5), taking action (§8.6), evaluation (§8.7), and learning specified (§8.8), is presented in the context of newcomer (N) students. It is incorporating technology into the subject modules, with the focus on students new to the module, and their experience. The final section concludes the chapter with a summary (§8.9). The deliverable of this chapter is enhanced aspectual engagements framework guidelines.

8.2 ELEMENTS RELEVANT TO THIS STUDY

As referred throughout the study, the refined Checkland and Holwell (1998b:23) model are directing the research plan as depicted in Figure 8.1. The focus of this chapter is on a real-world problem (P), which is solved through the application of action research (M_R).

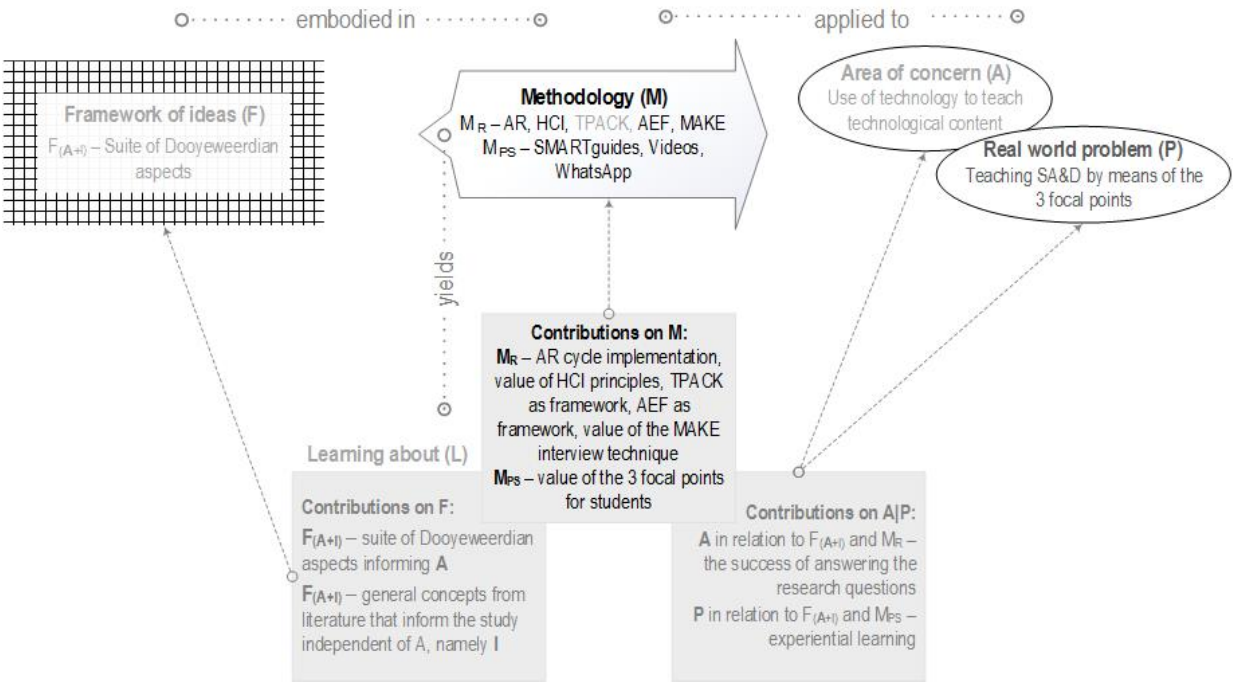


Figure 8.1: The elements relevant to this chapter

The problem is embedded in the subject modules of systems analysis and design (SA&D) and how it is taught to **newcomer** information technology (IT) students, with a particular focus on the three cases of technology instruments – SMARTguides to guide instructional design, Videos for formative guidance, and WhatsApp groups guiding summative assessment (M_{PS}). Interviews are guided by HCI principles and the aspectual engagements framework (M_R), based on the philosophy of Dooyeweerd.

8.3 AR CYCLE N – BACKGROUND

In Chapter 4 the derived HCI foci were extracted from literature. In Chapter 7, derived HCI foci were aspectually analysed and the AEF, based on the Dooyeweerdian suite of modal aspects, applied to investigate the technology implementation of this AR cycle.

In 2015 the SA&D first semester class was split into two groups: repeating students and newcomer students. The module that was taught to the previously combined group continued with the newcomers. In addition, the three focal points were fully operational at this time. This cycle concerns the group of newcomer students.

The research question for this iteration is stated as:

> *How can the lecturer utilise the three focal points, each with its particular niche in SA&D, to create a limber environment that will ensure that especially the* ***newcomer***[7] *students reach their potential?*

Subsequently the five-step interactive AR process is used as research method in this chapter (Susman & Evered, 1978:588): the problem is diagnosed; a plan of action is compiled; action is taken; the action is evaluated; and learning is specified.

8.4 AR CYCLE N – DIAGNOSIS

This intervention with SA&D newcomer students has the purpose to emancipate students through the incorporation of the three focal points into instructional design, as discussed in Chapter 2, Section 2.5.1.4. At the point of splitting the class, a secondary concern was whether the focus of newcomer students may be hampered by the presence of repeating students in the class?

Similar to the repeaters' AR cycle presented in Chapter 5, Churchman (1968:29) steers the step of diagnosis with his five considerations of a system, in this instance the educational system of SA&D: purpose, environment, resources, components, and the management. As discussed in Section 2.4.3, the five considerations allow insight into the situation, it opens up the scenario for critique, and eventually it enables transformation (Alvesson & Deetz, 2000:17).

This section focuses on the instructional design of the SA&D module for newcomers which is viewed as a "*system*" in the context of the systems approach. With this section building on the original context of the study, Table 8.1 includes the contextual information from Table 3.1 in Chapter 3. In the table each characteristic is described, which is followed by a contextual reference, and then the information regarding this iteration is stated.

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[7] In the previous AR cycle performed in this study, repeating students were the focus.

Table 8.1: Churchman's considerations in diagnosing the instructional design of the repeater class of SA&D

Systems characteristic	Diagnosing the instructional design of SA&D
Purpose	Purpose: the purpose of a system is described as the overall, measurable objective of the system. Churchman (1968:31) argues that the real objective is not always clear, and typically the objective is that which will not be jeopardised by other decisions.
Context	The objective of the overall instructional design as a system is to guide each student to develop in terms of their SA&D skills and as life-long learner.
Class of newcomer students	Initially a student as newcomer to SA&D, with no SA&D background, was the inspiration for the instructional design. The underlying nature of the SA&D subject modules themselves were also taken into consideration, where a plethora of techniques are made available, each suited to particular scenarios, and some across contexts. Keeping life-long learning in mind, students need to be able to decide when a particular tool will fit a matching situation. Awareness supported this goal. From a critical perspective, it is important to open up the material, overwhelming in its volume, while keeping students interested. Therefore, ways to acquire information and internalise the content, are important. It was important to make students aware that each individual only need to utilise the learning tools which help them to acquire the knowledge they need. Equal emphasis is placed on study units, and the weekly class tests and assignments require newcomer students to work and learn unceasingly throughout the semester. Similar to the group of repeating students, the focus of the newcomer group was not placed on the pass rate of SA&D, but rather to create an environment supporting all student preferences regarding the acquiring of information.
Environment	Environment: Churchman (1968:36) posits that the environment of a system cannot be influenced by the system, but it influences the objectives of the system.
Context	The environmental aspects of this study are: • Poor socio-economic background. • Limitations in practical laboratories on campus. • Specific functionality of the LMS outside campus boundaries. • Limited contact time: only two double contact sessions. • Limited study hours per module in the programme.
Class of newcomer students	Limited contact time in SA&D, a subject relying on students spending much time in analysing, designing, and developing a prototype, make students dependent on access to either their personal devices, or practical venues. Since practical venues are used by all university students, it is of the utmost importance to balance the limited contact time available between covering theoretical concepts and the practical application of concepts, with the support provided when students venture outside the classroom in developing the practical group project. This aspect of the environment is more important in the newcomer context in comparison to the repeater context, since it is their first exposure to project work in the IT course.
Resources	Resources: opposed to the environment, resources can be manipulated in the system and utilised to reach the objective of the system (Churchman, 1968:37).
Context	In support of the subject plan preceding the AR cycles, shown in Chapter 3, Figure 3.2, the learning resources which were relied on to support students in their endeavour to internalise concepts, with the motivation for the inclusion of each, can be referred in Table 3.3. The instruments contributing to the participation mark of the students – for both semesters – is shown in Table 3.4.

Systems characteristic	Diagnosing the instructional design of SA&D
Class of newcomer students	The three focal points were at different stages of development before the splitting of the class. Therefore, with the splitting of classes, the three focal points could be utilised as resources for both groups. All the resources made available to SA&D students before the class split, are still used for newcomer students after the split (Table 3.2). In the same way by which all this material is available to repeating students, although not in a way where it contributes marks, the material used by repeating students is made available to newcomer students, again, not in a way where it contributes marks: material prepared, and feedback on quizzes, happy hours, and expert witnesses. The instruments which are contributing to the participation mark of the group of newcomer students, is shown in Table 8.2. The allocations for the second semester stay as it was indicated in Table 3.3.
Components	Components: components are subsystems in support of reaching the overall objective of the system. Each subsystem also has the characteristics of a system as listed in this table (Churchman, 1968:39).
Context	With different strageties for dividing the systems into components possible, it was decided to combine teaching and learning – along with the study units as components – with the contextual focus on the students and the splitting of the original class into a class group of repeaters and a class group of newcomers. After dividing the SA&D class group into two main components, for repeaters and for newcomers, this refined component division is applied to the group.
Class of newcomer students	The newcomer class, is the second component, which is addressed in the AR cycle involving newcomer students. Teaching and learning enable the overarching objective of developing a positive and rich learning environment in which newcomer and repeating students are encouraged to actively participate and thereby developing their full potential. The weekly teaching of study units individually supports the management of the overall objective. In support, the three focal points collaborate with the study units to ensure the overarching objectives of the subject modules are achieved.
Management	Management: management is the coordination of the resources which are subject to the constraints of the environment – by means of the components – in order to achieve the stated objective (Churchman, 1968:44).
Context	The initial intention regarding the subject modules was to teach the modules in a structured way. Resources were developed with the following outcomes in mind: the lecturer needed to familiarise herself with the subject material as taught in this particular context, before making any major adjustments to the classes, and continuous preparation of the material by students was required, to ensure that all the material may be learned well. Assumptions made by the lecturer, include: • The NWU Sakai-based LMS, eFundi, was used as much as possible to facilitate the teaching of the subject modules. • To motivate students to prepare for class, class tests should be written before a class is offered. • To ensure continuous learning, each study unit had an accompanying assignment. • To facilitate students' capability to apply learned concepts in a practical setting, a weekly class work activity was completed. Project groups had the intention to encourage students to work on their projects weekly. To support progress, three guiding instruments were utilised for the projects.
Class of newcomer students	The inclusion of the three technology tools has required the amendment of the original subject plan, to support the implementation of the envisaged educational purposes underlying them. The updated subject plan is shown in Figure 8.3. The focus of the group of newcomer students is on attending to a study unit scheduled for a particular week, with the intention to internalise the new material by placing it in context with what was covered previously, and anticipating how the material of a study unit links to subsequent material. A bird's eye view of the semester's work is therefore important and perpetually kept in mind.

The compilation of the participation mark is shown in Table 8.2.

Table 8.2: Instruments contributing to the participation mark

Semester 1 Group: newcomer students	Number	Weight
Weekly class test (10 tests)	10	10
Weekly assignment (10 assignments)	10	10
Semester tests	2	50
Group project 1. Consultation (5) 2. Final presentation & demonstration (20)	 1 1	 30

The original subject plan which was shown in Chapter 3, Figure 3.2 is shown once more, in Figure 8.2.

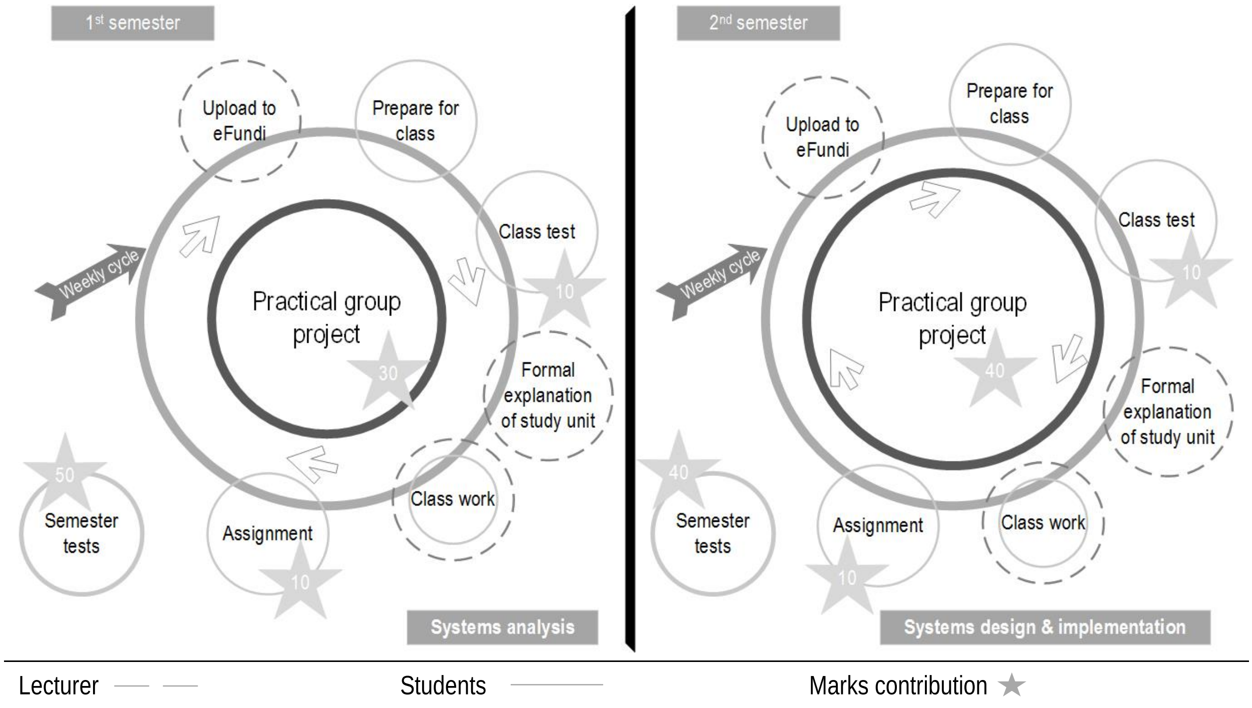

Figure 8.2: Original subject plan

The adjusted subject plan is shown in Figure 8.3. It is an amendment to the original subject plan.

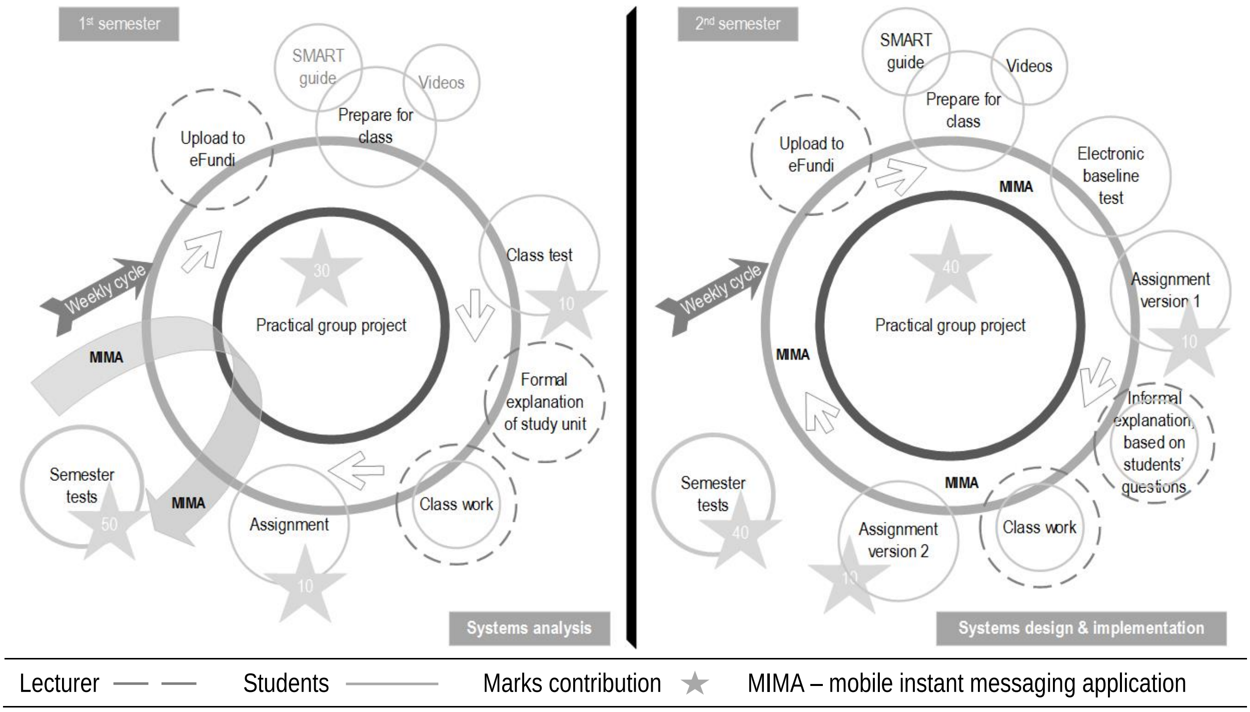

Figure 8.3: Adjusted subject plan – newcomer students

Both semesters are shown in the revised subject plan for newcomer students, which directs the management of the instructional design of SA&D, and all activities performed. The resources of the system are indicated with circles. Each weekly cycle starts with the necessary resources and activities being uploaded onto eFundi – part of the instructional design environment, and progresses clockwise. Circles with broken lines are showing eFundi uploads or printouts by the lecturer. Solid circles show activities done by students, either individually or in groups. The components as focal points form part of the weekly cycle. For example, the WhatsApp group as mobile instant messaging application (MIMA) implementation, is formed during the first semester, while it supports the full second semester. Assessments and the weight contribution of each is shown with stars.

8.4.1 Conclusion of the diagnosis of this AR cycle

The problem that is addressed in this AR cycle, is that students new to SA&D, did not have sufficient educationally sound technology support (Chapter 2, Figure 2.8) to allow them to develop towards their full potential.

8.5 AR CYCLE N – PLANNING FOR ACTION

Planned action assigns activities intended to relieve problems in the research environment. The discovery of these actions is guided by a theoretical framework, chosen to guide the approach to and the target for change that would address such problems (Baskerville, 1999:15).

The conceptual guidelines extracted through the application of the AEF and the incorporated eight derived HCI foci (Chapter 4), has been compiled in Chapter 7, Table 7.10. It is shown again here in Table 8.3, numbers indicated correlate with the importance allocated to each by Hinze-Hoare. The conceptual guidelines will guide this AR intervention cycle.

Table 8.3: Conceptual guidelines, viewed in the context of the three focal points, are mapped to the derived HCI foci

No.	Derived HCI focus	Conceptual guideline
1	Consistency and familiarity facilitate learning	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.
2	Guide users by using physical and logical constraints	Q: Only the MIMA groups have a size limitation in terms of the members accommodated. In all focal points a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number.
		Sp: All types of devices should be considered, but special attention should be given to mobile devices with its small screens, making it imperative to compile compact chunks of information.
		O: Units of material should be compact, and a limited number of facts should be conveyed in an engaging way.
		F: When possible, the integration of tools may support the guidance which should be provided by any educational technology tool.
		Ec: Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.
		J: An educational tool should fulfil its purpose and provide the guidance, information, or clarity accordingly to ensure that what is due for all is made available.
3	Flexibility allows for effective use	So: Of the three focal points, only the WhatsApp group supports social interaction, but the three focal points should consider the diversity of cultures of its users to ensure widespread use.
		Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.
4	Prevent mistakes, or allow for its clear identification	Li: In the case of all three focal points, engagement with content relies on the lingual. This may be supported by other mechanisms, but care should be taken to convey the same message.
		A: Technology tools should be designed in a way which is aesthetically pleasing. It should involve the user in a colourful, playful and fun environment.
5	Allow for recovery from mistakes by returning to a previous state	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.
6	Capabilities performed according to user intentions	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.

No.	Derived HCI focus	Conceptual guideline
		Pi: The focal points facilitate in-depth learning which should affect students beyond the classroom.
7	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses	Ph: Tools should support the visual, as well as the auditory by presenting clear displays and sound.
		Se: Colour and sound, combined with a strong message which clearly conveys the purpose of a concept may facilitate understanding.
		Lo: The coordination of tools should support the logical progression of the presentation of material.
8	Timely communication of task status	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.
		Li: In the case of all three focal points, engagement with content relies on the lingual. This may be supported by other mechanisms, but care should be taken to convey the same message.

Two aims of this intervention are to emancipate students new to SA&D enabling them to reach their full potential, which is partially achieved by means of the second aim, namely to verify and refine the guidelines extracted in Chapter 7. An interview technique, making use of unstructured questions guided by the Dooyeweerdian suite of modal aspects, is used for this purpose.

8.6 AR CYCLE N – TAKING ACTION

In this context, the intervention where newcomer students are the focus, their emancipation, in order to achieve their intended potential, along with the introduction of the three technology instruments. Therefore the aim in this regard is twofold: the expansion of the resources available to students to support them in their preparation to become information system development specialists; and to constitute the educational purpose of each technology instrument. The technology instruments are categorised in the educational themes of, formative guidance, summative assessment, and instructional design, in chronological order of implementation:

1. With traditional classes offered to newcomer students, the introduction of short videos on challenging concepts intended supporting the acquisition of new information – in support of scaffolding knowledge in the mind of the learner. It allows students to decide whether they need the additional support, which supports self-directed learning.
2. The formation of WhatsApp groups facilitated the educational purpose of students using their already existent mobile devices to learn from peers and have the support

of their lecturer when they prepare for assessments. A dedicated newcomer group was formed to ensure that no comments regarding the different focus of the repeating group would confuse this group of students.

3. The development of interactive electronic study guides created the opportunity for the third educational purpose of adding a study guide to the mobile device in the hand of students.

Subsequently the order of discussing the three focal points is logical – overall instructional design (represented by the SMARTguides), focussed formative guidance (represented by the Videos), and concentrated guidance for summative assessment (represented by the WhatsApp groups).

Again, throughout the introduction of the technology tools, the fact that the interactive electronic study guides are the only technology tool designed for its purpose, is kept in mind: WhatsApp is not designed to be utilised as a teaching and learning tool – but rather for socialising, and the traditional use of videos is in a much broader context – although they do have some record as a teaching tool. It is accepted that, especially in the case of the WhatsApp groups, the evolution of a tool, the size of groups, and the composition of a particular group pose specific challenges. These limitations have been utilised to extract the conceptual guidelines, and it is anticipated that the guidelines posed as outcome of this study, will guide future implementations.

The intervention which is the subject of this AR cycle includes newcomer students using the three focal points in their context, from 2015 to 2018 (Chapter 2, Figure 2.8).

In order to supply supporting information regarding the introduction of the three technology instruments, Table 8.4 displays information on a set of criteria, namely, its purpose, objective, material to support the instruments, lecturer support, how the focus changes between the first and second semesters, and the software technology used to develop the instrument. The aspects applicable to only the newcomer students are shown in *italics*.

Table 8.4: The three focal points; SMARTguides, Videos, and WhatsApp groups listed, using a set of criteria

Topic	SMARTguides	Videos	WhatsApp groups
Objective	To guide students throughout each module by dividing the work into weekly topics with interactive material.	*To assist students in their preparation of challenging concepts and to support revision of challenging concepts.*	To support students in their preparation for assessments.
Action to create	Designing, developing, testing, implementing and support of interactive electronic study guides referred to as SMARTguides: • S - Student • M - Management • A - Assessment • R – Remediation • T – Tracking.	Identifying challenging concepts from each study unit, then the production of short videos on those concepts.	Gathering information from students on their preferences regarding MIMAs to be used on their mobile devices and then forming groups according to the needs of the students.
Resources in support	Supporting material: • All material referenced is stored as eFundi Resources. • Feedback on the practical project done by groups of students supports the guidance provided by the SMARTguide, as it prompts students to convert the theory studied, to its practical implementation. • Feedback from students regarding the SMARTguides uses the eFundi Wiki.	Supporting material: • Prescribed text book used for class preparation. • Slides grouped per specified outcome. • Slides used for teaching specified outcomes. • Preparation of specified material – additional reading. • Formal classes offered. • Feedback on class related actions is stored as eFundi Resources.	Supporting material: • *Baseline class tests are written and feedback on tests are provided on eFundi Resources.* • *Formative assessment assignments are done and feedback are provided on eFundi Resources.* • Semester test preparation sessions are conducted. • Semester Tests are written and feedback are provided on eFundi Resources. • Examination preparation sessions are conducted to prepare for summative assessments.
Lecturer support	Academic Development and Support.	Student Assistants, Supplemental Instructors and Tutors.	Administrative staff, Invigilators and Student Assistants.
Supporting technology	SMARTguides are produced in MS PowerPoint, then converted to Articulate Storyline and finally stored in PDF-format.	In 2011 the VC acquired a technology tool, SmartPodium, which enables the production of videos. Videos are also produced using suitable software like Blueberry FlashBack Express, then stored as a Firefox HTML document to be uploaded on eFundi.	WhatsApp as MIMA is used to create a group or groups. Every member receives all messages sent by any other member. In addition to text, it allows for photographs, voice messages and video-clips to be distributed.
Access to components	A downloadable link is supplied on eFundi Resources. Instructions regarding access to supporting software are supplied.	Videos are uploaded onto eFundi Resources to be watched and/or downloaded. It is also embedded into the SMARTguides to allow access when SMARTguides are downloaded onto student devices.	The mobile phone is the primary device. Supporting applications along with an Internet connection allow access via tablets, laptops and PCs as well.

Topic	SMARTguides	Videos	WhatsApp groups
Change of focus from 1st to 2nd semester	Guidance supports normal instruction in the first semester and reverse instruction in the second semester.	No formal teaching of concepts to support reverse instruction; a class focuses on the specified outcomes related to the study unit covered, student questions asked, and questions formulated by the lecturer to encourage discussion of relevant work. Class Work is expanded to address group work related to specified outcomes – in support of the focus placed on the development of practical group projects.	Baseline class tests and its feedback are written on eFundi before class and therefore is taking up no class time. Fewer semester tests are written to allow more time for students to reminisce and work on their projects.

With the three focal points of this study standing central to the teaching & learning of SA&D, in addition to improving the experience of students, the success of the technology instruments regarding its use in the context of newcomer students, is scrutinised. The literature regarding HCI principles, as discussed in Chapter 4, and the aspectual engagements framework (AEF), based on the work of Dooyeweerd, and discussed in Chapter 7, apply.

8.7 AR CYCLE N – EVALUATION

This AR Cycle N intervention entailed placing the focus on newcomer students supported by the three focal points of this research. Two parts were addressed, namely problem solving, where students were supported to enable them to reach their full potential, and research, where guidelines were refined through a process of evaluation which manifested in revisiting deductions made from literature regarding the derived HCI foci, and the AEF, interview development, the data collection strategy, and the analysis of the collected data.

8.7.1 Data analysis strategy

Chapter 2 refers, to guide the data analysis strategy to be followed in addressing the empirical objective of this chapter. Figure 2.9, which shows the content analysis process adapted from Elo and Kyngäs (2008:110) and was applied in Chapter 5 (§5.7.1), is used here once again. In Figure 8.4 the directed approach of content analysis followed here, is highlighted in grey.

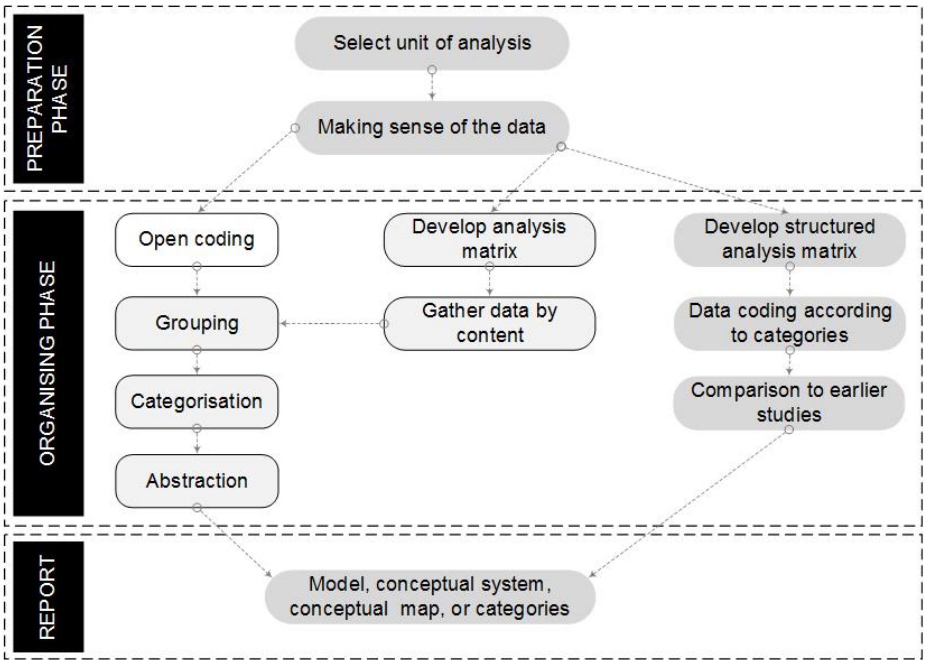

Figure 8.4: The content analysis process as adapted from Elo and Kyngäs (2008:110)

The Hermeneutic Circle with its double hermeneutic reporting is employed as mode of analysis of this study. It serves as overarching principle. The three effects anticipated are: (1) any presuppositions the researcher may have which may affect the gathering of data, and questions asked will determine the answers of participants; (2) when analysing data, the data is affected, and contrariwise data affects its analysis; and (3) the context of an interview needs to be considered when meaning is attached to words used in the data.

The directed content analysis approach shown in Figure 8.4 directs data analysis as follows:

- To select the unit of analysis is the first step in preparing the data. In the case of this study, the unit of analysis is an entire interview with a participant – which is recorded for reference purposes. By considering an interview with a specific participant as unit of analysis, the researcher could obtain a wider understanding than the specific.
- Make sense of the data and the whole conclude the preparation of the data. Asking questions regarding *who* (spoke), *where* (did it happen), *when* (did it occur), *what* (happened), and *why* (it happened) while listening to each recording several times will assist the researcher in becoming fully immersed in the data.
- The organisation of the qualitative data is started with a developed structured analysis matrix. This process started in Chapter 4 and Chapter 7 with the compilation of the HCI foci from literature and the aspectual analysis directed by the AEF. The interviews

are guided by the suite of Dooyeweerdian aspects which also guided the development of the conceptual guidelines – to obtain enhanced HCI-AEF guidelines.

- Data is coded according to the 15 modal aspects, while listening to each interview with the intention to describe all aspects of the interview. It often requires someone to listen to an interview more than once. Codes are represented in table format.
- The coded data is then compared to the set of conceptual guidelines obtained from aspectually analysing the three focal points. This step concludes the organisation of the data.
- Report on the enhanced HCI-AEF guidelines obtained. This is done in the "*Learning specified*" step of the AR cycle.

Trustworthiness implies mindfulness, and is reflected upon when data analysis is completed. A list of questions have been formulated in Chapter 5 (Table 5.7) to guide trustworthiness. This same list of questions is used to show the trustworthiness of this AR cycle in Table 8.5.

Table 8.5: List of questions designed to guide content analysis towards trustworthiness from Elo and Kyngäs (2008:110)

No.	Question to guide trustworthiness	Motivation	Result
1	Is the process of analysis as well as the ensuing results described in enough detail?	It should be clear to readers how the analysis was done. Its restrictions and strengths should be highlighted.	A dissected process and rigorous results.
2	Are the themes described by its categories, and categories by its codes?	Groupings should be anchored empirically, as well as conceptually.	Simplified data that is analysed and grouped to reliably reflect the subject under scrutiny.
3	Does the groupings cover the data well?	The researcher should be able to defend illations on sound and authentic collected data.	Detailed reporting that describes the analysis process, as well as the results. The inclusion of tables and appendixes may highlight links between the raw data and ensuing results.
4	Is the context, the participants, data collection, and analysis process described thoroughly?	Readers should be able to trace the process of inquiry followed.	Transferable research.
5	Are citations from the empirical data included without pointing to participants' identity?	Readers should be able to determine the origination of groupings.	Increased trustworthiness.
6	Was content validation done? A number of content validation techniques are available, including face validity, and the use of agreement coefficients. Options for seeking agreement may utilise a panel of experts, or dialogue among co-researchers.	Agreement on the grouping and labelling of data.	Valid coding and grouping of content.

8.7.2 Interview development

It was planned that, with the start of each interview, the ethical approach of study would be stated and the "*AUTHORITY FOR SA&D INTERVIEWS AR CYCLE R & N"* (Annexure B) signed. The compilation of this document was guided by the TRREE ethics course: "*ETHICAL CLEARANCE*" (Annexure A).

An introductory discussion focused on the background of the study and the HCI foci.

In addition, it was planned that some biographical and background information would be gathered. These basic questions are listed in Table 8.6.

Table 8.6: List of initial questions designed to gather biographical and background information from participants

No.	Question	Motivation
1	What is your current age?	Age may allow comparisons between interview groups.
2	Why did you decide to study IT?	Determine whether participant had a clear motivation for his/her IT studies.
3	What is your current status?	Determine whether the participant is a student, studying a post-graduate degree, staying at home, or working?
4	What is the job you are currently doing?	If the participant is working – to determine whether the participant is involved in the IT industry.
5	What is your long term plan regarding your career?	Determine whether the participant has a clear vision for his/her future career in IT.
6	In which year were you enrolled for SA&DI?	Establish the year of SA&D-I enrolment.

In this AR cycle a list of questions to ask participants is not prepared, but the Multi-Aspectual Knowledge Elicitation (MAKE) interview technique, as developed by Winfield (2000:286) to investigate the knowledge people have developed on a topic, is followed. The MAKE interview technique as discussed in Chapter 7 (§7.6), is discussed here in terms of its planned implementation in this AR cycle:

STEP 1 – ***Introduction***: briefly explain the 15 modal aspects of Dooyeweerd to the participant. A printed list of aspects will be used for reference purposes. In this study, it was decided to include all modal aspects as indicated by Winfield (2000), and not to omit the first five as suggested by Kane (2005). Aspectual maps were also not used.

STEP 2 – ***Statement of requirements***: the focus of the information to be elicited from participants include the three focal points and the derived HCI foci established in Chapter 4. A printed list of the HCI foci will be used for reference purposes.

STEP 3 – ***Question the participant***: apply the aspectual template from step 1 to the derived HCI foci in the context of the three focal points from step 2 and identify the important aspects. For each important aspect, question the participant by:

- isolating one aspect and then specifying laws, axioms, data, definitions and constraints which apply within it to the domain in question.
- identifying as many concepts (examples from the study) as possible that lie in this aspect. Here the interviewer may need to check whether the concepts fall in the correct aspect.
- determining properties of a thing (the application of Low Level Abstraction) to expand on each concept. This may identify new concepts and/or highlight the links between them.

STEP 4 – ***Enrich understanding***: Use the aspectual template to identify any new aspect(s) that may apply to the concepts already specified. Use an aspectual map (A drawing representing the modal aspects, each with one or more concepts included, and an indication of how they are linked to one another) to build bridges between concepts and aspects.

8.7.3 Data collection

With the content analysis approach outlined, and the MAKE interview technique selected, the participants were recruited to be interviewed. From the students who were enrolled as newcomer students of SA&D for the period 2015 to 2018, a list of names and contact numbers were compiled. The list were compiled from former students known as candidates who would be able to proficiently articulate their experience. These former students were then contacted via WhatsApp. The first six potential participants who were contacted all agreed to be interviewed, and appointments were made to suit the candidates.

As planned, each interview session consisted of four parts:

1. Each session was started by welcoming the participant, and emphasising the anonymity of the person. An accompanying "*AUTHORITY FOR SA&D INTERVIEWS AR CYCLE R & N*" (Annexure B) was signed.
2. The initial questions listed (Table 8.6) were asked to gather biographical and background information from participants.

3. The focus of the research in terms of the derived HCI foci in the context of the three focal points, and the suite of modal aspects (steps 1 and 2) were explained and discussed.
4. An introductory question which did not form part of the modal aspects, determined which of the three focal points were used by the participant, whether the experience was positive, and why a particular tool was not used if that was the case. The identification of important aspects with regard to the derived HCI foci in the context of the three focal points, was pursued. The interrogation of each aspect identified to extract information which apply within it, included listing as many examples from the study as possible. To make sure that all important aspects were covered, links were established between an aspect under discussion and other aspects. Two follow-up questions were asked, namely whether any particular improvements to the SA&D subject modules may be suggested, and the advice a participant has for a student new to SA&D. Point 4 was recorded. The starting and ending time for each code compiled is listed in "*ACTION RESEARCH CYCLE N – CODE LISTS WITH START AND END TIMES*" (Annexure E). Coding excerpts listed as footnotes in Table 8.9, up to Table 8.37, were transcribed as verbatim responses.

8.7.4 Participant detail

The six participants, named P1… P6, are listed in Table 8.7. The table includes the name of the audio file, as well as biographical and background information.

Table 8.7: List of answers to initial questions designed to gather biographical and background information from participants

Participant detail	Clear motivation for IT study	Long term vision for IT	Current status	Current job
Participant: P1 Audio file: SM Age: 20 Gender: F Enrolled: 2018	Computer Application Technology (CAT) as school subject piqued interest.	Combining systems analysis in a database environment.	BSc IT, final year	N/A
Participant: P2 Audio file: PS Age: 24 Gender: F Enrolled: 2018	Come from a rural village, has a dream to build an IT college there to uplift the people.	Unsure	BSc IT (Extended), final year	N/A

Participant detail	Clear motivation for IT study	Long term vision for IT	Current status	Current job
Participant: P3 Audio file: EJ Age: 21 Gender: F Enrolled: 2017	Computer Application Technology (CAT) as school subject piqued interest.	Business analyst, front-end developer (UI).	BSc IT (Hons)	NWU IT internship
Participant: P4 Audio file: LC Age: 26 Gender: M Enrolled: 2017	Always interested in technology.	To first work in the IT industry, and then move to an academic position.	BSc IT (Hons)	NWU part time lecturer
Participant: P5 Audio file: WM Age: 22 Gender: M Enrolled: 2016	Did IT as subject at school. It started with Scratch in grade 9.	Work my way towards a senior position in IT.	Working	Full-time employee at a software house (NetRec), as junior systems programmer.
Participant: P6 Audio file: NK Age: 28 Gender: F Enrolled: 2015	Computer Application Technology (CAT) as school subject piqued interest, studied Computing course at WITS (unsuccessful because of mathematics).	Work my way towards a leadership position in Enterprise / Cloud Architecture.	Working	First year full-time employee at Vodacom as business analyst (product development) – after a 2 year graduate program.

The participant detail forms the background for the presentation and analysis of the data.

8.7.5 Data presentation, analysis and findings

In an attempt to address trustworthiness (point 4 in Table 8.5), the steps identified in Section 8.7.1 in terms of the data analysis strategy, are followed here.

The ***unit of analysis*** as first step in preparing the data, has been established to be an entire interview done per participant. The interview strategy has been outlined (§8.7.1) from extant literature (§7.6 Table 7.12). Data was collected (§8.7.3) and participant information related (§8.7.4).

Making sense of the data and the whole, involved studying the completed interview page and listening to each interview recording several times over, while asking questions (*who* (spoke), *where* (did it happen), *when* (did it occur), *what* (happened), and *why* (it happened)). This enabled the researcher to become fully immersed in the data.

Develop a structured analysis matrix, a process started with the compilation of the conceptual guidelines which guided the interview process. The suite of Dooyeweerdian aspects are applied to the derived HCI foci by aspectually analysing the three focal points with the purpose to verify and refine the guidelines.

Data is coded according to the structured analysis matrix. Codes were compiled while listening to each interview with the intention to describe all aspects of the interview.

With no questions being formulated, the modal aspects with keywords, an explanation, and the *good* associated with each aspect formed part of the documents the participants had access to during the interviews. Although care was taken not to guide participants toward an expected answer, the interviewer supplied an example when explaining each modal aspect to each participant. In all interviews, it was important to hear each participant's voice.

At the start of each interview, participants were requested to indicate their usage of the three technological focal points. This knowledge guided each interview. With the first interview, the three focal points were discussed individually. This arrangement resulted in an interview which lasted 2 hours 30 minutes, more than double the time indicated by Winfield (2000:238), as well as Kane (2005:97). Since examples on focal points following the first (WhatsApp groups), did not bring new examples to the fore, it was decided to interview participants on the three focal points at once, and allow them to decide which focal point affords the best examples per modal aspect. This arrangement resulted in shorter interviews of between 40 minutes and 100 minutes. After discussing all modal aspects, participants were requested to indicate any improvements to SA&D, and what their advice would be to students new to SA&D.

Cross-case analysis is applicable once more, but on a more detailed scale when compared to its application in Chapter 5 (Seaman, 1999:567). In this AR cycle, the codes extracted from a particular interview were again treated as a "*case*", in this cycle allowing five groups of data to be compared in pairs. In addition, the individual discussions of the three focal points were also treated as groups of data, with codes on the latter focal points (SMARTguides and Videos) added only when it enriched the data.

Codes were formulated for the examples participants supplied per modal aspect and are represented in Table 8.10 to Table 8.39. In the table a bullet (●) represents a response which was expected by the researcher from the context of the situation. Bullets are numbered to ensure traceability. Unexpected responses – from the point of view of the researcher – was indicated with a circle (O) to distinguish it from an expected response. An unexpected response is motivated in a footnote with a corresponding number, with the inclusion of an interview excerpt. When a response of a subsequent participant was added which was not indicated as a response of a participant yet, the content was revisited. Therefore, in all cases, an interview was listened to more than once. For all coding occurrences, the codes were tallied, and code totals are shown per modal aspect (or question) and for each participant per modal aspect (or question).

To allow the focus to fall on the three parts of the code table, it is discussed in the three sections following.

8.7.5.1 Value of the focal points

The first part of the code table, involves ***the grouping of the data, and application of abstraction***, applied once more, as was done in Chapter 5, but only to three explicit questions asked. Only the first question (with its resulting network diagram) is discussed here:

- To what extent was the three focal points used, and what value did it hold?

The purpose of the presentation, analysis and findings of this section, is to scrutinise the problem solving part of this AR intervention, to determine how future newcomer students may be emancipated to reach their full potential.

8.7.5.1.1 Presentation of the codes

The codes are presented in Table 8.8.

Table 8.8: List of codes regarding the value of the focal points, applied to the interviews done with participants

Establish the extent to which the three focal points were used							
Codes for this question	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
The SMARTguide was easy to use						[1]●	1
The SMARTguide guided my focus while studying		[2]●	[3]●				2
I used the SMARTguide when I prepared for the second examination opportunity	[4]●						1
I had limited use for the SMARTguide				[5]●	[6]●		2

Establish the extent to which the three focal points were used							
Codes for this question	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
I watched the videos extensively					[7]●		1
I watched videos (selectively) – to learn the concepts	[8]●	[9]●	[10]●			[11]●	4
I did not use the videos				[12]●			1
The WhatsApp group was of much value to me, it kept me informed	[13]●	[14]●	[15]●	[16]●	[17]●	[18]●	6
The WhatsApp group was of much value to me, although I did not post messages	[19]●	[20]●	[21]●	[22]●			4
TOTAL	4	4	4	4	3	3	22

8.7.5.1.2 Analysis of the codes

The three focal points are each addressed in the analysis of the codes.

Although participants indicated that they under-utilised the SMARTguides, all participants did refer to it for some academic purposes. Two participants indicated that it was of limited use to them (P4, P5). One participant indicated that it was easy to use (P6). Its use varied from accessing it to guide one's focus when studying (P2, P3), only using it for the second opportunity examination of the second semester – when the participant wanted to improve her final mark.

Varied responses were given regarding the use of the videos, one participant (P5) indicated that he relied a lot on the videos, four (P1, P2, P3, P6) indicated that they watched the video when there was a concept they did not understand. One participant (P4) was not aware of the videos.

Among the interviewed participants, everybody found the WhatsApp groups of much value, even though four participants (P1 to P4) indicated that they were not comfortable to post messages on the WhatsApp class group. This discussion is represented in the network diagram shown in Figure 8.5.

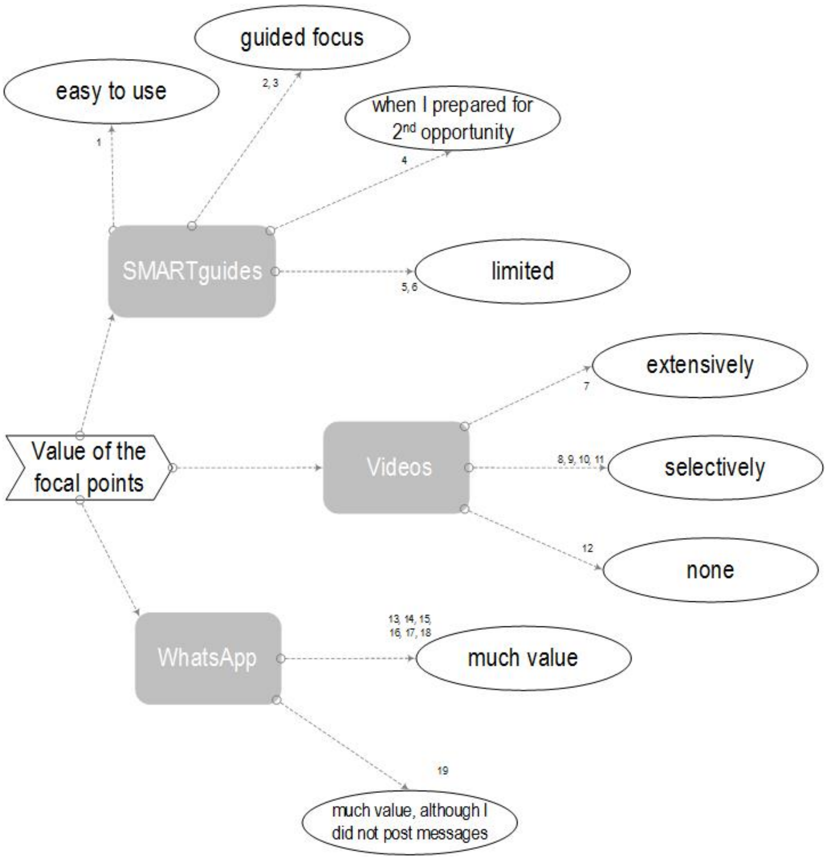

Figure 8.5: Network diagram showing theme "Value of the focal points", with its categories, each with grouped codes

8.7.5.1.3 Findings following from the analysis

The success of the intervention in terms of the "*Value of the focal points*" to the participants, are:

1. The SMARTguides were used with varied intensity by all participants. The integration of greater interactivity, and information on assignments, the group projects, and any other credit baring activities may encourage students to access it frequently. Accessibility on mobile devices is valuable.
2. Videos were extensively watched by one participant, when a need arose by four participants, and not used at all by one participant who were not aware of its existence. These differences emphasizes the importance of naming videos according to each one's focus to allow selective viewing.
3. The WhatsApp groups held much value to participants, even when they did not post messages. It may be necessary to guide the academic intent with basic rules, and in

some cases it may be necessary for the lecturer to post questions, and other posts to motivate students.

8.7.5.2 Modal aspects

With fifteen modalities under discussion, the code table is presented per modal aspect, to allow the immediate analysis, and the presentation of findings of each. All modal aspects are subsequently discussed in this way, with Table 8.9 being the first to include the codes for the modal aspects of which the spatial is the first, to the last one being the pistic modality – in the order suggested by Dooyeweerd. Subsequently "the story which the data tell", is considered. The purpose of the analysis, is the **comparison of findings to the earlier study (completed in Chapter 7), done when the coded data is compared to each of the conceptual guidelines**. The result is a modality guideline amendment which is suggested. Then the guideline is enhanced, based on this amendment.

The purpose of the presentation, analysis and findings of this section, is to scrutinise the problem solving part of this AR intervention, to determine how future newcomer students may be emancipated to reach their full potential.

Analysis is done according to the outline provided in Chapter 7, Table 7.10. Therefore a specific guideline may support more than one derived HCI focus, and it occurs according to the context of the foci the guideline supports.

The codes not analysed, are applicable to resources beyond the three focal points and are grouped into categories and themes along with the two questions which was asked and are to be discussed in the third and last part of the code table discussion.

8.7.5.2.1 Quantitative modality

Presentation of the codes

The codes reflecting the quantitative modal aspect is shown in Table 8.9.

Table 8.9: List of codes pertaining to the quantitative modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
The videos were a great help to me					[23]●		1
Videos on more complex examples may help one to understand					[24]●		1

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
Videos on OO may support students working in an agile environment					25●		1
The whole class is accommodated on a WhatsApp group		26●					1
Larger numbers of students on WhatsApp groups require more control						27●	1
Even though our WhatsApp group was big, only a small number of people posted messages	28●						1
The size of a WhatsApp group determine the dynamics of communication				29●			1
Opinions may be gauged on the WhatsApp group			30●				1
We used the class WhatsApp group to create spinoff project groups			31●				1
The larger project group sizes allow some students to slack						32●	1
The number of tools allow students to select which ones to use						33●	1
TOTAL	1	1	2	1	3	3	11

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.10. The focus is on indicating all codes which are either challenging a particular guideline, or are benefiting a particular guideline, representative of reverberations and functioning. The purpose of this step is to verify and refine this **conceptual guideline**:

> Only the MIMA groups have a size limitation in terms of the members accommodated. In all focal points a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number.

Table 8.10: Codes mapped to the conceptual guideline (quantitative modality) in the context of the derived HCI focus

Applicable derived HCI focus	Impact	
	In support	A problem
2) Guide users by using physical and logical constraints	[23] The videos were a great help to me [26] The whole class is accommodated on a WhatsApp group [28] Even though our WhatsApp group was big, only a small number of people posted messages [30] Opinions may be gauged on the WhatsApp group [31] We used the class WhatsApp group to create spinoff project groups	[24] Videos on more complex examples may help one to understand [25] Videos on Object-Oriented may support students working in an agile environment [27] Larger numbers of students on WhatsApp groups require more control [29] The size of a WhatsApp group determine the dynamics of communication

Once more, participants relayed that focal points have much value and examples accommodated per focal point (for example videos) should vary in terms of complexity. This would allow students to utilise what they need to use to progress in their endeavour to learn. They created project groups in addition to class groups. Code occurrences 23-31 refer.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> The introduction of technology tools are important, and when of value it is used beyond the formal class setting. Technology tools should include a wide range of topics, with examples covering simple to complex issues.

This finding results in the **enhanced guideline** (to emphasize the update, any part of a guideline that has been changed, is shown in *italics*, and the part amended is shown in **bold**):

> Only the MIMA groups have a size limitation in terms of the members accommodated. In all *technology tools* a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number. **Examples should cover from the very simple to complex issues.**

8.7.5.2.2 Spatial modality

Presentation of the codes

The codes reflecting the spatial modal aspect is shown in Table 8.11.

Table 8.11: List of codes pertaining to the spatial modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
I could not use the SMARTguide on my phone				[34] ●			1
One can use the WhatsApp group anywhere, anytime	[35] ○			[36] ○			2
My mobile device helped me to study continuously		[37] ●	[38] ○		[39] ●		3
The focal points helped me to re-cap what was covered in class					[40] ●		1
When missing a class, the tools helped one to catch up					[41] ●		1
The space where one stays impacts your studies						[42] ●	1
Participation in group work may be dependent on how far members stay from one another						[43] ●	1
TOTAL	1	1	1	2	3	2	10

[35] [P] Because I'm thinking, the good thing about the WhatsApp group, like the environment, wherever you are, you can start a discussion. Even, whatever the time … for me, I prefer to study in the early hours … most of the time, at 2AM I am awake … [I] That is really nice. So, it doesn't matter whether you're at university, whether you're at home, whether … [P] In a taxi …

[36] [P] First thing I have already identified, is WhatsApp – spatial, … because that was the one big benefit of the WhatsApp group; you can ask questions, any time, any place, students were … like I said, I did not ask questions much, but I didn't really have to because there was always someone asking the same question, and just that freedom of always having, I mean sometimes you would, before a test, I would not have my notes with me, because I try not to study, like in 5 minutes before … [I] It makes you stress? [P] Yes, but then you remember, oh, what is the four whatever of … Then I remember this student did mention something about is on the group, let me quickly … oh, okay, I have that … it is a nice thing to have access to the WhatsApp group anywhere, anytime, wherever you are. I think spatial is a big thing with WhatsApp.

[38] [P] Spatial is basically where you're at, right? So, I think the only way we can say that spatial is included it's class time, that's where we're together as a group, and afterwards when we work on the class work and the project. So, then we would normally get together … those were the only two spaces that we (were together). [I] … Do you think that when you're not face-to-face with your lecturer and your peers that you can still be in a space where you can learn about SA&D? Do you think that, with your cell phone in your hand … that puts you in a virtual space where you are not in class, but learning? [P] Ja [Yes], when I studied … I would have the PC open with maybe the videos and my textbook, and then on the phone asking: "Oh, is this what we are supposed to do?", and then I have my book here, with maybe my notes, or something. [I] Then you will jump from the one to the other. So, linking to that virtual space, do you think the three … uhm, focal points helped us to extend our class beyond the traditional class? [P] Ja [Yes], … (it helped me) to go deeper into it, because I would then sit with my textbook and try to properly understand what is going on here. So, you don't always need to be in class.

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.12. The purpose of this step is to verify and refine this **conceptual guideline**:

> Only the MIMA groups have a size limitation in terms of the members accommodated. In all focal points a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number.

Table 8.12: Codes mapped to the conceptual guideline (spatial modality) in the context of the derived HCI focus

Applicable derived HCI focus	Impact	
	In support	A problem
2) Guide users by using physical and logical constraints	[23] The videos were a great help to me [26] The whole class is accommodated on a WhatsApp group [28] Even though our WhatsApp group was big, only a small number of people posted messages [30] Opinions may be gauged on the WhatsApp group [31] We used the class WhatsApp group to create spinoff project groups	[24] Videos on more complex examples may help one to understand [25] Videos on Object-Oriented may support students working in an agile environment [27] Larger numbers of students on WhatsApp groups require more control [29] The size of a WhatsApp group determine the dynamics of communication

Participants pointed out that focal points have more value when accessible on a mobile device (WhatsApp), while one participant related his limited use of the SMARTguide to the fact that he could not access it on his phone. Code occurrences 34-39 refer.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> Effort should be made to make mobile versions of tools available, since the value in technology tools lie in the ability of the user to access it anywhere, and at any time.

This finding results in the **enhanced guideline**:

> With all types of devices considered, special attention should be given to mobile devices – **to accommodate technology tools**. Because of its small screens, it is imperative to compile compact chunks of information.

8.7.5.2.3 Kinematic modality

Presentation of the codes

The codes reflecting the kinematic modal aspect is shown in Table 8.13.

Table 8.13: List of codes pertaining to the kinematic modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
I do not need to do much in terms of movement to converse on WhatsApp	[44]●						1
I can do much when I had my phone in my hand		[45]●					1
It is comforting to know I have technology to support me					[46]●		1
The focal points were not used (effectively) in other subjects					[47]●		1
Technology requires less effort to get answers to questions					[48]●		1
I can be helped even at inconvenient times					[49]●		1
We managed the development of our documentation on Google Docs			[50]●				1
One needs to be open to change in our work environment				[51]●			1
It is good to hear the perspective from a Student Assistant who recently did SA&D						[52]●	1
SA&D links with other subject modules in our course						[53]●	1
TOTAL	1	1	1	1	4	2	10

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.14. The purpose of this step is to verify and refine this **conceptual guideline**:

> Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.

Table 8.14: Codes mapped to the conceptual guideline (kinematic modality) in the context of its derived HCI foci

Applicable derived HCI focus	Impact	
	In support	A problem
1) Consistency and familiarity facilitate learning 3) Flexibility allows for effective use 8) Timely communication of task status	[44] I do not need to do much in terms of movement to converse on WhatsApp [45] I can do much when I had my phone in my hand [46] It is comforting to know I have technology to support me [48] Technology requires less effort to get answers to questions [49] I can be helped even at inconvenient times	[47] The focal points were not used (effectively) in other subjects

The kinematic conceptual guideline is fully supported by the codes in support and being a problem regarding the focal points and no **suggested modality guideline amendment** is formulated.

Findings following from the analysis

With kinematic conceptual guideline fully supported by the codes in support and being a problem regarding the focal points, it is retained as **enhanced guideline**.

8.7.5.2.4 Physical modality

Presentation of the codes

The codes reflecting the physical modal aspect is shown in Table 8.15.

Table 8.15: List of codes pertaining to the physical modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
WhatsApp was a backup in terms of answering my questions					[54]●		1
The conversation on the WhatsApp group kick-started my learning				[55]●			1
On WhatsApp, the commitment of peers energised me	[56]●						1
The fact that peers helped one another on WhatsApp motivated me	[57]●						1
The physical is a given		[58]●					1
Working through past papers energised me			[59]●				1
If you are well rested, you can focus in class			[60]●				1
Making our own videos for class created energy among group members						[61]●	1
TOTAL	2	1	2	1	1	1	8

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.16. The purpose of this step is to verify and refine this **conceptual guideline**:

> Tools should support the visual, as well as the auditory by presenting clear displays and sound.

Table 8.16: Codes mapped to the conceptual guideline (physical modality) in the context of the derived HCI focus

Applicable derived HCI focus	Impact	
	In support	A problem
7) Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses	54 WhatsApp was a backup in terms of answering my questions 55 The conversation on the WhatsApp group kick-started my learning 56 On WhatsApp, the commitment of peers energised me 57 The fact that peers helped one another on WhatsApp motivated me 58 The physical is a given	- -

Participants were energised and motivated by the commitment of the lecturer and the progress of their peers. They valued the fact that there was support backup in the form of technology tools, even without needing it. Code occurrences 54-57 refer.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> The commitment of the lecturer and the progress of peers relayed via technology tools, motivated students, and energised them. The support system provided in the form of technology tools were comforting to students.

This finding results in the **enhanced guideline**:

> With all types of devices considered, special attention should be given to mobile devices – **to accommodate technology tools**. Because of its small screens, it is imperative to compile compact chunks of information.

8.7.5.2.5 Organic modality

Presentation of the codes

The codes reflecting the organic modal aspect is shown in Table 8.17.

Table 8.17: List of codes pertaining to the organic modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
Breathing is something that is involuntary	[62] ●	[63] ●	[64] ●		[65] ●		4
One needs to be sensitive to stress relief in a stressful job such as IT				[66] ●			1
Initially I did not care for myself, and could not cope with study demands						[67] ○	1
Where you stay influence your energy levels, because traveling is exhausting						[68] ●	1
TOTAL	1	1	1	1	1	2	7

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.18. The purpose of this step is to verify and refine this **conceptual guideline**:

> Units of material should be compact, and a limited number of facts should be conveyed in an engaging way.

Table 8.18: Codes mapped to the conceptual guideline (organic modality) in the context of the derived HCI focus

Applicable derived HCI focus	Impact	
	In support	A problem
2) Guide users by using physical and logical constraints	[62, 63, 64, 65] Breathing is something that is involuntary	[66] One needs to be sensitive to stress relief in a stressful job such as IT [67] Initially I did not care for myself, and could not cope with study demands [68] Where you stay influence your energy levels, because traveling is exhausting

[67] [P] So, with the organic, the breathing, circulation, I think it's just something that we normally take for granted, you are not feeling well … and you see yourself doing all these things … because when I was still here (at university) I was not taking care of myself, I think … [I] The stress catches up with you? [P] Yes. [I] And you went out of home. At home your parents make sure you eat what you are supposed to eat. [P] Yes, and here you eat whatever is there, the cheapest thing you can get. That also affects our bodies would also be … and at some point I went on a journey where I started taking care of my body … It would help me with regards to classes, because I used to fall asleep a lot in class … you're very lethargic, you can't keep up with the content, you cannot balance your group work you're class work, assignments, activities …

Participants learned that one needs to rest well, eat nourishing food, and keep active to facilitate energy levels required to study a challenging course. Code occurrences 66-68 refer.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> Participants acknowledged that attention to one's well-being is crucial to ensure optimal functioning as students.

The findings result in the **enhanced guideline**:

> Units of material should be compact, *to present contained information designed to engage,* **and to allow for breaks**.

8.7.5.2.6 Sensitive modality

Presentation of the codes

The codes reflecting the sensitive modal aspect is shown in Table 8.19.

Table 8.19: List of codes pertaining to the sensitive modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
The WhatsApp groups motivated me		[69] ●					1
Using English on WhatsApp showed sensitivity to all						[70] ●	1
I needed to use the SA&D WhatsApp group for the purpose it was created						[71] ●	1
Students express their emotions on the WhatsApp group			[72] ●				1
Emotional reactions on WhatsApp is inappropriate				[73] ●			1
Knowing there is a WhatsApp group, is good for your morale					[74] ●		1
Insensitivity on WhatsApp was not a problem					[75] ●		1
I was sensitive to some racial inequality topics discussed in our WhatsApp small groups	[76] ○						1

[76] [P] With me, I take everything as feelings … [I] So, your feelings are sensitive? [P] Yes. So, if, like I explained when I got a zero for the first test, it affected me badly, like feelings, okay. So, because of that, my sensitivity, right, it motivated me to carry on, to … [I] But now, if you look at the WhatsApp environment … Can you give me examples …? [P] Uhm, it has to be the way people communicate in the group. [I] Okay, and what is the way that they communicate? [P] … if people start, like, sensitive topics on the group, like with the whole … it could be ... the whole racial inequality thing, some people had that whole thing of: "we failed because of" … [I] … there is a white lecturer and we are black students? [P] Yes, that type of thing … So, it's topics like that, they immediately divide us, right? There is always people that … obvious … the white students, the black students … Such topics, they shouldn't

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
When we shared past papers, we also shared answers, which helped	77 ●						1
The lecturer tracked our class work uploads, which motivated us	78 ●						1
TOTAL	3	1	1	1	2	2	10

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.20. The purpose of this step is to verify and refine this **conceptual guideline**:

> Colour and sound, combined with a strong message which clearly conveys the purpose of a concept may facilitate understanding.

Table 8.20: Codes mapped to the conceptual guideline (sensitive modality) in the context of the derived HCI focus

Applicable derived HCI focus	Impact	
	In support	A problem
7) Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses	69 The WhatsApp groups motivated me 70 Using English on WhatsApp showed sensitivity to all 74 Knowing there is a WhatsApp group, is good for your morale 75 Insensitivity on WhatsApp was not a problem 77 When we shared past papers, we also shared answers, which helped	71 I needed to use the SA&D WhatsApp group for the purpose it was created 72 Students express their emotions on the WhatsApp group 73 Emotional reactions on WhatsApp is inappropriate 76 I was sensitive to some racial inequality topics discussed in our WhatsApp small groups

Participants emphasized that technology should be used in a way which recognises and accommodates all members, and for the purpose it was created. Code occurrences 69-76 refer.

be discussed ... What I saw, is, people, … they didn't discuss it in the WhatsApp group, but they use WhatsApp, because we had another WhatsApp group, … so if something happens, they go on the side … and they discuss it, and it's like: "it's because we are black …". But, it must be like something that … [I] triggered it? [P] Yes. [I] There was a test, and you didn't do well in the test, or whatever …? [P] Or, it could be the release of participation marks … [I] And then they will look for a reason …? [P] And it always went back to racial inequalities.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> For the successful utilisation of technology tools, it should be used in a way which recognises and accommodates all members, and for the purpose intended.

The findings result in the **enhanced guideline**:

> Colour and sound, combined with a strong message which clearly conveys the purpose of a concept, may facilitate understanding. **An academic focus should be encouraged.**

8.7.5.2.7 Logical modality

Presentation of the codes

The codes reflecting the logical modal aspect is shown in Table 8.21.

Table 8.21: List of codes pertaining to the logical modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
The SMARTguide directed my focus in SA&D		[79] ●					1
The logical layout of the SMARTguide was helpful				[80] ○			1
Videos focuses on what the lecturer wants you to know			[81] ●				1
I listened to videos sub-consciously, repeatedly						[82] ●	1
Logical thinking on the WhatsApp groups is appropriate				[83] ●			1
I need to think logically to be able to answer questions on WhatsApp	[84] ●						1
One needs to verify answers supplied by peers on WhatsApp					[85] ●		1
We researched tools in class which I used in the work place as well						[86] ○	1
One needs to logically think through a problem in IT					[87] ●		1

[80] [P] I think in some way the logical, I can apply it to the SMARTguide although I didn't use the SMARTguide as much, but the logical layout of the SMARTguide. [I] Okay, did it help you? [P] Ja [Yes]. Definitely. There was no struggle about where to go, where to navigate, because it made sense, it was clear, if I wanted to know under the study unit where project information is, I click on the tab … the learning curve with the SMARTguide is not really a learning curve, it's logical, … intuitive. Like with these HCI principles, there is consistency familiarity, it has menus, it is intuitive.

[86] [P] There were a lot of activities where you asked us to go and research, uhm, like, can you search for prototyping tools, can you search for presentation tools, CASE tools. So, and I even when, at the workplace I even went to that folder, where I actually looked for some of these things …

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
TOTAL	1	1	1	2	2	2	9

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.22. The purpose of this step is to verify and refine this **conceptual guideline**:

> The coordination of tools should support the logical progression of the presentation of material.

Table 8.22: Codes mapped to the conceptual guideline (logical modality) in the context of the derived HCI focus

Applicable derived HCI focus	Impact	
	In support	A problem
7) Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses	[79] The SMARTguide directed my focus in SA&D [80] The logical layout of the SMARTguide was helpful [81] Videos focuses on what the lecturer wants you to know [82] I listened to videos sub-consciously, repeatedly [83] Logical thinking on the WhatsApp groups is appropriate [84] I need to think logically to be able to answer questions on WhatsApp [85] One needs to verify answers supplied by peers on WhatsApp	- -

Participants recognised that one needs to logically consider where to find answers to questions, and then also logically consider answers supplied by peers. Code occurrences 79-85 refer.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> One needs to logically consider answers supplied by peers, in addition to considering where to find answers to questions.

The findings result in the **enhanced guideline**:

> The coordination of tools should *allow* the logical progression of the presentation of material **according to the user's needs**.

8.7.5.2.8 Formative modality

Presentation of the codes

The codes reflecting the formative modal aspect is shown in Table 8.23.

Table 8.23: List of codes pertaining to the formative modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
The SMARTguide assisted me with my planning			[88]●				1
The videos and the textbook complemented one another						[89]●	1
I was motivated to work harder when you shared the statistics of SA&D assessments	[90]○						1
I prepared one chapter per day for assessments		[91]●					1
SA&D is offered in a structured way, which helps students to cope with the workload				[92]●			1
Teaching IT subjects should simulate the culture of a work environment				[93]●			1
I made notes that I studied from					[94]●		1
I started the study process with my textbook					[95]●		1
The slides amended the textbook					[96]●		1
I planned well to start early to study for assessment					[97]●		1
The lecturer needs to communicate why activities are expected						[98]●	1
I use my textbook in my work environment						[99]●	1
TOTAL	1	1	1	2	4	3	12

[90] [P] When you post things, like, the stats, like the marks, like … how many distinctions we've got. That, kind of, it pushes a person. It changes your goals. [I] So, you are now saying, I would say … that is the highest mark, that type of thing? [P] Yes. … like it changed my goal, right, it pushed me to want to achieve a better mark. So, I don't think … put people on the spot, just give the stats … [I] Ja [Yes], not the person? [P] Ja [Yes], Just the stats. [I] I could say that: "In this group, the highest mark was an 85, and there were three people who got above 70", or something like that? So, I am not naming anybody …? [P] Yes. I remember you did it on … systems two, after writing the semester test … with the results, you named the people with the highest marks, and my question was still: "why is it not me?" <laughs> [I] <laughs> So, how did you experience that? If your name was there, would it have motivated you? [P] You did call my name, I was part of, I think the top 10, or was it the top 5? Ja [Yes]. But still, I didn't like that the other 5 people, like: "Why? Why is it not me?" <laughs> So, yeah, it is just my competitive nature. But that helps. It helps motivate other people. But, others, they just, because with other modules, right, our marks, you get a spreadsheet with everyone's student number and sometimes with name and surname, you can see everyone's marks … that's the thing … you shouldn't like put students on the spot, it's just not good. [I] Except if you did well … [P] That's what the whole posting of the spreadsheet, if I did well, I'm happy … if I do badly, I just feel bad about it, and it's like, okay, now people can see my bad mark …

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.22. The purpose of this step is to verify and refine this **conceptual guideline**:

> When possible, the integration of tools may support the guidance which should be provided by any educational technology tool.

Table 8.24: Codes mapped to the conceptual guideline (formative modality) in the context of the derived HCI focus

Applicable derived HCI focus aspect	Impact	
	In support	A problem
2) Guide users by using physical and logical constraints	88 The SMARTguide assisted me with my planning 89 The videos and the textbook complemented one another	- -

Participants valued a variety of tools to use as they prefer to enable them to follow a strategy of learning – to ensure they fully understand a concept and the material as such. Code occurrences 88-89 refer.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> A variety of technology tools should be provided to use – to allow a student to plan, and be guided to fully understand a concept – in a way determined by individual preferences.

The findings result in the **enhanced guideline**:

> The integration of **electronic** tools may support the **planning for learning and** guidance which should be provided by *an* educational technology tool.

8.7.5.2.9 Lingual modality

Presentation of the codes

The codes reflecting the lingual modal aspect is shown in Table 8.25.

Table 8.25: List of codes pertaining to the lingual modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
The videos helped me to learn SA&D terminology			[100] ●				1
The communication variety on WhatsApp assisted discussions				[101] ●			1
The way people express themselves on WhatsApp, make us feel we belong	[102] ●						1
WhatsApp recordings are difficult to multithread				[103] ●			1
Missing non-verbal communication can cause misunderstanding on WhatsApp						[104] ●	1
We communicated in English on all communication forums		[105] ●			[106] ●		2
Home language determined the group formation						[107] ●	1
Terminology was easy to learn					[108] ●		1
I did additional reading on new concepts					[109] ●		1
TOTAL	1	1	1	2	3	2	10

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.26. The purpose of this step is to verify and refine this **conceptual guideline**:

> In the case of all three focal points, engagement with content relies on the lingual. This may be supported by other mechanisms, but care should be taken to convey the same message.

Table 8.26: Codes mapped to the conceptual guideline (lingual modality) in the context of its derived HCI foci

<table>
<tr><th rowspan="2">Applicable derived HCI focus aspect</th><th colspan="2">Impact</th></tr>
<tr><th>In support</th><th>A problem</th></tr>
<tr><td>4) Prevent mistakes, or allow for its clear identification</td><td rowspan="2">[100] The videos helped me to learn SA&D terminology
[101] The communication variety on WhatsApp assisted discussions
[102] The way people express themselves on WhatsApp, make us feel we belong
[105] We communicated in English on all communication forums</td><td rowspan="2">[103] WhatsApp recordings are difficult to multithread
[104] Missing non-verbal communication can cause misunderstanding on WhatsApp</td></tr>
<tr><td>8) Timely communication of task status</td></tr>
</table>

Participants found communication via electronic means valuable, but they also recognised the impact of the missing non-verbal communication associated with technology. Code occurrences 100-105 refer.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> Participants value the effectiveness of electronic communication such as that which occur on a WhatsApp group, but also recognised the detrimental effect of the absence of non-verbal communication.

Participants did not supply any feedback regarding the communication from the focal points, such as status feedback relevant to WhatsApp – pertaining to derived HCI focus 4. Therefore the findings result in the **enhanced guideline**:

> In the case of all three focal points, engagement with content relies on the lingual. *All possible communication mechanisms (pictures, videos, etc.) should be encouraged*, *to convey the intended message and to ensure consistency*.

8.7.5.2.10 Social modality

Presentation of the codes

The codes reflecting the social modal aspect is shown in Table 8.27.

Table 8.27: List of codes pertaining to the social modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
WhatsApp was used to allocate jobs to be done for the project	110 ●						1
Sharing of past papers on WhatsApp helped us to study	111 ●						1
The SA&D WhatsApp group could sometimes deviate	112 ●						1
I would use the WhatsApp search option to search for the lecturer's messages	113 ●						1
We discussed concepts on WhatsApp		114 ●					1
We also socialised on the WhatsApp group			115 ●				1
It was easy to get help from a peer through WhatsApp				116 ●			1
The WhatsApp group helped to build relationships among peers						117 ●	1

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
Light humour – on WhatsApp – before assessments helped for stress release					[118] ●		1
I am a WhatsApp extrovert and an introvert in real life						[119] ●	1
Working with a peer on WhatsApp					[120] ●		1
Project group interaction facilitated the development of soft skills				[121] ●			1
Group work motivates me to put in more effort				[122] ○			1
TOTAL	4	1	1	3	2	2	13

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.28. The purpose of this step is to verify and refine this **conceptual guideline**:

> Of the three focal points, only the WhatsApp group supports social interaction, but the three focal points should consider the diversity of cultures of its users to ensure widespread use.

[122] [P] In my second year, groups were like aagh … [I] It is a lot of schlep, né? [P] Ja [Yes]. Like, there is good and bad to both, work individually and in groups, but now that we are doing honours, most of our projects and assignments, everything is individual, there is no group work, and I miss that now. I miss that collaboration, because … [I] You also learn from it … [P] Ja [Yes]. You actually learn more working together than working on your own, because in my case when I work in a group, it is not only my marks that will be influenced by the work, but other people's marks, and then I tend to put in more effort into the work. [I] So, it motivates you? [P] Definitely, group work motivates me, and it is not always the case for all students, because some students will say, aah, group work, everyone else will do it … With individual work I'm like, it's my mark, … and then sometimes you will just quickly do something, just to get it done … [I] And it's not on the standard that you like, [P] Ja [Yes]. That is something that I miss about group work, that environment. [I] So, that is possibly why you refer to the fact that you're actually working in a simulated group with your data warehouse project? [P] Yes. [I] You are working individually, but you sit together to share … I know something that you don't know, and you know something that I don't know, and eventually we get to a higher level, or we go deeper … [P] Exactly. And not only that, also the social aspect to it.

Table 8.28: Codes mapped to the conceptual guideline (social modality) in the context of the derived HCI focus

Applicable derived HCI focus aspect	Impact	
	In support	A problem
3) Flexibility allows for effective use	110 WhatsApp was used to allocate jobs to be done for the project 111 Sharing of past papers on WhatsApp helped us to study 113 I would use the WhatsApp search option to search for the lecturer's messages 114 We discussed concepts on WhatsApp 115 We also socialised on the WhatsApp group 116 It was easy to get help from a peer through WhatsApp 117 The WhatsApp group helped to build relationships among peers 118 Light humour – on WhatsApp – before assessments helped for stress release 119 I am a WhatsApp extrovert and an introvert in real life 120 Working with a peer on WhatsApp	112 The SA&D WhatsApp group could sometimes deviate

Participants found both the class group and their own groups on WhatsApp of value. They also acknowledged the value of light humour on the groups, but felt that socialising on such groups has its place and should be moderated. Code occurrences 110-120 refer.

Findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> Participants found much academic value in the WhatsApp groups. Although social interaction is also valued, it should be contained in a group used for learning.

The findings result in the **enhanced guideline**:

> Of the three focal points, only the WhatsApp group supports social interaction. **The social side should be moderated in an academic implementation.** *All technology tools* should *accommodate* a diversity of cultures of its users to ensure widespread use.

8.7.5.2.11 Economic modality

Presentation of the codes

The codes reflecting the economic modal aspect is shown in Table 8.29.

Table 8.29: List of codes pertaining to the economic modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
Videos were distributed on WhatsApp		[123] ●					1
Most students will ensure they have WhatsApp access, even with limited funds	[124] ●						1
One needs to plan to use your data bundle frugally					[125] ●		1
After hours I would help peers with resources from eFundi, via WhatsApp	[126] ○						1
Many students cannot access eFundi off campus		[127] ●					1
Students may use the technology tools instead of attending classes			[128] ○				1
I was a privileged student in terms of funding				[129] ●			1
Not having sufficient funding influences your access to technology devices and data						[130] ○	1
TOTAL	2	2	1	1	1	1	8

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.30.

[126] [P] But with others, right … with other people, even when they're at home, right, it's still, what's that word? So, it's with, the group, right, using, what's this? A friend of mine will go home, right, where there is no Wi-Fi. They can't get eFundi notifications, right? So, then I share … so, they are connected to WhatsApp, they just don't have enough data to open the Internet and check eFundi, or view their e-mails. [I] So, eFundi is not accessible when they're not having Wi-Fi? [P] Yes. [I] You're then their access, or they have somebody who have access, who relates it to them? [P] Yes. So, … because some, what's this? Resources, we can share them on WhatsApp. I can share the electronic textbook, slides, question papers … instead of sending them on e-mail … [I] So, you think it is a frugal way to use the R29 that you have (to pay for WhatsApp access)? [P] Yes.

[128] [P] May I ask; this economic budgeting, say for instance for students who can't always attend classes. Wouldn't that help them with savings, so that you don't always have to come to campus – because those resources are available online? [I] So, they don't have taxi money? [P] Mmm … [I] Ja [Yes], definitely. Especially if you plan it. Not do it haphazardly, but you would say, that, uhm, "I can get certain information from a particular class". [P] Mmm … [I] And that's a day when I do not have many other classes, so I am going to save that 20 bucks. [P] Yes. [I] And not come to class, because I can find it through another way. That would be a good way of … [P] Especially with the e-guide also, because say for instance, if you are a shy person for instance, and you don't have a lot of friends in class and you don't really know what's happening. Maybe you were sick or something and you couldn't attend class, then you know the e-guide is also there. [I] You can actually earn on your own. [P] Yes.

[130] [P] I think also, the finance play a role with regards to the tools you can use … your infrastructure. So data is something else, … you might not have a smartphone, you might not have the money for it as well … and also for things like laptops, you know. [I] The technology, the devices that you need … [P] Yes. Maybe you would be queuing for, I am not sure how many labs there are? There may be a queue just to get a PC … AT least now smartphones are getting cheaper and cheaper, and there is Wi-Fi.

The purpose of this step is to verify and refine this **conceptual guideline**:

Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.

Table 8.30: Codes mapped to the conceptual guideline (economic modality) in the context of the derived HCI focus

Applicable derived HCI focus aspect	Impact	
	In support	A problem
2) Guide users by using physical and logical constraints	[123] Videos were distributed on WhatsApp [124] Most students will ensure they have WhatsApp access, even with limited funds [125] One needs to plan to use your data bundle frugally [126] After hours I would help peers with resources from eFundi, via WhatsApp [128] Students may use the technology tools instead of attending classes	[127] Many students cannot access eFundi off campus

The economic conceptual guideline is fully supported by the codes in support and being a problem regarding the focal points and no **suggested modality guideline amendment** is formulated.

The findings following from the analysis

With the economic conceptual guideline fully supported by the codes in support and being a problem regarding the focal points, it is retained as **enhanced guideline**.

8.7.5.2.12 Aesthetic modality

Presentation of the codes

The codes reflecting the aesthetic modal aspect is shown in Table 8.31.

Table 8.31: List of codes pertaining to the aesthetic modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
SMARTguide is easy to navigate and it is well-designed				[131] ●	[132] ●		2
The videos facilitated my understanding		[133] ●					1
The videos summarised concepts		[134] ●					1
Videos helped me to explain concepts to peers						[135] ●	1

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
I watched videos actively			[136] ○				1
WhatsApp and videos facilitated aha-moments					[137] ●		1
The WhatsApp facilitated understanding				[138] ●			1
When discussions flow on the WhatsApp group, we get answers to questions	[139] ●						1
The WhatsApp group is a safe place for shy students	[140] ●						1
The WhatsApp group helped us to share previous exam papers				[141] ●			1
Appropriate jokes on WhatsApp relieved stress, while being funny as well	[142] ●						1
We de-stressed after tests on WhatsApp						[143] ●	1
I could load tools on my laptop		[144] ●					1
Explaining concepts to peers made me feel like an expert						[145] ●	1
The classes where we used GLOGs were fun			[146] ○				1
Class tests facilitated scaffolding			[147] ○				1

[136] [P] And I think the videos also helped us in that sense, because then you know what to focus on for the test. You can see – this is important, and … [I] … You went through all the videos? [P] Yes. [I] Did you watch a video more than once? [P] I did, especially if we had to write a test, and exam, then … [I] So, you will maybe do it when you do the chapter, and then you will do it for the semester test, and ... but when you watch a video now … did you have a need to watch it again, now? [P] No, because … [I] So afterwards you … [P] What I normally did is if I sit and watch the video I will have my notepad thingy there. [I] So, you're actively busy? [P] Ja [Yes], because it's the same as in class, you make your notes also. [I] Ja [Yes], in the same way. Then there was something else that I wanted to know. What do you think about, because the way I make videos is I look at what is difficult for students to learn, but I don't make a difficult video, I try to make a simple video of a simple problem of that challenging concept. [P] I remember the ERD (video). It really helped me a lot. [I] To understand? [P] Ja [Yes]. [I] The fact that I am not doing a difficult example, is that fine? How do you go about how to learn how to do an ERD for a difficult scenario? How did you do it? [P] I think one should have the basics, so you go through the video, it shows you the basics, right? Then you go to past papers. [I] It builds? [P] Yeah … And afterwards you look at your semester test, and say: "Ah, okay, this is where I went wrong, oh, okay this is right." So, now I know this is what I should do next time. Then you know for the exams. You are better prepared … it's better to make the mistake in the semester test.

[146] [P] Uhm those, there were a few classes where we did … uhm, where we did … uhm, where we did those playful things, uhm, the … I can't remember the name of it? [I] GLOGs? [P] Yes, those things <laughs>. It was so fun, because everyone could interact with everyone, so … [I] Because we had a competition. [P] Yes. [I] One half of the class will go look at the other and then swop it. I think throughout the whole year there was something like three sessions like that. [P] Yeah. [I] Where we used GLOGs. So, would you place it under 'aesthetic'? [P] Yes. It was really fun. I think most of us was looking forward to those classes <laughs>. [I] Did it help you to learn? [P] It did. It did, and I think it also improved uhm the team work. [I] Ja [Yes], because you had to do it in your group. [P] Yes. I think it helped with that also. [I] Do you think, uhm, no, let me re-phrase. How did you go about building your GLOGs? Can you remember? Can you describe it to me? [P] Okay, first of all we would look at the scenario, right? And then afterwards we would put it on paper first. Like, oh okay, this is what we want in it, and after … [I] So, you have a plan? [P] Yes … we took the information that was given … so, from … uhm … didn't we also have to make a … what's this? Like, something like a notes type of thing, a summary, and then we took it from there. [I] Okay. And did you use it to study, or? [P] Yes. We did. Because the summary is from different people, then you can see, oh okay, that person focused on that, maybe I must also focus on it … [I] So, it was easy for you to study the things you've put in your own words? [P] Ja [Yes].

[147] [P] And then we also had those class tests, I think it helped a lot, because if you go through … uhm … through the chapter then you know a little bit about the chapter. Then you explain it in class, then you know a little bit more, and then there's the videos … [I] Did you prepare for class? [P] Because we had to write the test. The first class I didn't – because I didn't expect the test. [I] You

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
Making our own videos on SA&D topics were fun						[148]●	1
Consultation feedback on our project was constructive						[149]●	1
TOTAL	3	3	3	3	2	5	19

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.32. The purpose of this step is to verify and refine this **conceptual guideline**:

> Technology tools should be designed in a way which is aesthetically pleasing. It should involve the user in a colourful, playful and fun environment.

Table 8.32: Codes mapped to the conceptual guideline (aesthetic modality) in the context of the derived HCI focus

Applicable derived HCI focus aspect	Impact	
	In support	A problem
4) Prevent mistakes, or allow for its clear identification	[131, 132] SMARTguide is easy to navigate and it is well-designed [133] The videos facilitated my understanding [134] The videos summarised concepts [135] Videos helped me to explain concepts to peers [136] I watched videos actively [137] WhatsApp and videos facilitated aha-moments [138] The WhatsApp facilitated understanding [139] When discussions flow on the WhatsApp group, we get answers to questions [140] The WhatsApp group is a safe place for shy students [141] The WhatsApp group helped us to share previous exam papers [142] Appropriate jokes on WhatsApp relieved stress, while being funny as well [143] We de-stressed after tests on WhatsApp [144] I could load tools on my laptop [145] Explaining concepts to peers made me feel like an expert	- -

never experienced that at university before? [P] <laughs>, no. [I] So, it was a shock on your system? [P] <laughs>, yes, from now on I better study. So, Ja [Yes], I think that helped a lot ... My average was like 3 (out of 5) or so, and when I really studied I got my 4 or 5 … [I] So, the experience of writing the test, it wasn't bad for you? [P] No, … [I] After the first one you took the challenge of preparing … [P] Ja [Yes], … what I did is, when I prepared for that, I wouldn't, because you don't really understand what's happening in it, and you don't really have a lot of time to go into depth. So, you look at say for instance whether you have bullets, and you look at diagrams. [I] You get an overview … Did I pitch (the class tests) correctly? [P] Yeah.

Although participants valued enjoyment often associated with technology, they also indicated that the use of technology in education should facilitate understanding. Code occurrences 131-145 refer.

The findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> Participants indicated that the aesthetic value of technology tools lies in the fact that it facilitates understanding, either through explanations facilitated by peers, or making material available that facilitates learning.

The findings result in the **enhanced guideline**:

> Technology tools should be designed in a way which is aesthetically pleasing and **to facilitate understanding**.

8.7.5.2.13 Juridical modality

Presentation of the codes

The codes reflecting the juridical modal aspect is shown in Table 8.33.

Table 8.33: List of codes pertaining to the juridical modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
The SMARTguide directed us			[150] ●				1
The WhatsApp group allowed us a platform to obtain answers to questions and share resources	[151] ●						1
I was listed as the top student on WhatsApp		[152] ●					1
Students have access to the devices we need for the focal points					[153] ●		1
The resources available in SA&D assisted deep learning				[154] ○			1

[154] [I] Do you think that, uhm, you needed them (the resources) to be able to be successful in my subject? Like, all the old test papers, and … [P] Ja [Yes], everything, I am not just talking about the three focal points, I am talking about everything that was there, and there was a lot. There was a lot. No, I feel like, if I didn't have all the resources, I probably would have passed, but not as ... it would have been much more difficult to reach the level I did, without the resources. [I]: So, you went deep? [P] Yes, I feel like it was, even though systems was, the work load of systems was quite large … I never felt too overwhelmed, because I knew, if I struggled with something, there was other resources, … especially old test papers. I mean that, a lot of lecturers do not put old test papers on eFundi. [I]: So, that was helpful to you? [P] That was how I studied. I did not make summaries of all the chapters, I did not go through the textbook, I literally took all the old big tests, semester tests, exam papers, looked at the memo, worked them out, referred to the textbook, make sure I know how to apply this, because sometimes you would study something, and you would go: "oh, I this activity-on-arrow, this … I can do it", then you get it (in an assessment) and you go: "Oh, #284, how do I do this?".

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
We had sufficient tools to guide us in SA&D					[155] ●		1
There is not a case to be made that we have too much support in SA&D					[156] ●		1
The outcomes of the subject directed my learning						[157] ●	1
We received feedback as promised, and you expected us to keep to set dates						[158] ●	1
TOTAL	1	1	1	1	3	2	9

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.32. The purpose of this step is to verify and refine this **conceptual guideline**:

> An educational tool should fulfil its purpose and provide the guidance, information, or clarity accordingly to ensure that what is due for all is made available.

Table 8.34: Codes mapped to the conceptual guideline (juridical modality) in the context of the derived HCI focus

Applicable derived HCI focus aspect	Impact	
	In support	A problem
2) Guide users by using physical and logical constraints	[150] The SMARTguide directed us [151] The WhatsApp group allowed us a platform to obtain answers to questions and share resources [152] I was listed as the top student on WhatsApp [153] Students have access to the devices we need for the focal points [154] The resources available in SA&D assisted deep learning [155] We had sufficient tools to guide us in SA&D [156] There is not a case to be made that we have too much support in SA&D	- -

Participants acknowledged the tools that helped them to stay positive within a challenging environment, and accentuated their value. Code occurrences 150-156 refer.

So, I think the old papers were the resource that had the most impact … I would see which questions came from which chapter, and I would group them together, and then I would try to see what work, in all three years, what work didn't it cover … I will look at the gaps, and sometimes, … I cannot see how this will be asked .. I will then make a judgement call.

The findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> Students should nurture a positive mind-set towards SA&D to ensure their willingness to make use of educational tools provided to them – to ensure their success.

The findings result in the **enhanced guideline**:

> **Users should want to access** an educational tool *which* fulfils its purpose and provide guidance, information**, motivation** *and/*or clarity *according to the immediate need* – to ensure that what is due for all is made available.

8.7.5.2.14 Ethical modality

Presentation of the codes

The codes reflecting the ethical modal aspect is shown in Table 8.35.

Table 8.35: List of codes pertaining to the ethical modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
The videos were beyond what we needed					[159] ●		1
WhatsApp groups should be managed when peers get out of hand	[160] ●						1
SA&D has a lot of information, it puts us under constant pressure		[161] ●					1
Assignments should cover two study units, not one		[162] ○					1
Preparing for class helped me to know what to expect			[163] ○				1

[162] [P] I think you should start giving students assignments after every two weeks, not every week <laughs>. *[I] Okay, so, you want to miss out on some of the assignment knowledge?* [P] Okay, maybe. Okay, maybe one assignment should include two chapters. *[I] Okay. So, you want a bigger assignment, but not every week?* [P] Yes, ma'am.

[163] *[I] You say you prepared for class. So, when you come to class prepared, in what way does it help you?* [P] Then you know what to expect in class basically. So then, say for instance if I looked at something and I don't understand what is happening here then I know in class I can ask – after you have explained and I am still not sure, then you know you can ask … *[I] What would you do (when you know the work I explain in class); check whether what I am saying is what you remember, would you phase out because you know (the work)?* [P] I think I, because I made my notes … I have my notes open … I will just listen to what you have to say. If there is anything to add to it, I will add it. *[I] Let's say (the class on ERDs) you went through it, but … you couldn't make out exactly how to do it. How will you listen and experience the class for that section of work?* [P] Okay, if like for the ERDs, when I didn't understand it, … I think I tried to focus on what you were saying in class, but I still didn't really get what to do until the videos … *[I] The videos you do after class?* [P] Ja [Yes].

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
My group took the challenge of learning according to the guidance provided			[164] ○				1
Group work relied on going the extra mile				[165] ●			1
Plagiarism software such as Turnitin directed us to do our own work						[166] ●	1
TOTAL	1	2	2	1	1	1	8

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.36. The purpose of this step is to verify and refine this **conceptual guideline**:

> The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, facilitate use beyond what is due.

Table 8.36: Codes mapped to the conceptual guidelines (ethical modality) in the context of its derived HCI foci

Applicable derived HCI focus aspect	Impact	
	In support	A problem
5) Allow for recovery from mistakes by returning to a previous state	[159] The videos were beyond what we needed	[160] WhatsApp groups should be managed when peers get out of hand
6) Capabilities performed according to user intentions		

Participants claimed that the use of technology inherently allows them to utilise material repeatedly. In addition, they valued a lecturer supporting the use of technology tools. Code occurrences 59-60 refer.

[164] [P] And then, with our group we also had to do our project. So, then that also really helped a lot, because I learned how to do ERDs there … We had a lot of diagrams in our … and then it really prepared me better … [I] My strategy is, you need to prepare for class test, then we have a class, then you have to work on your assignment, then we have class work where you basically do something towards your project, and then you need to do your project. Does that help you to go deeper each time? [P] It really helped a lot, because if I look at our exam mark – for my group members, we did really good, because we knew our diagrams … [I] The models were like in, instilled well? [P] Yes. [I] But you took the challenge of doing what I asked you to do. … [P] we did, Ja [Yes] …

The findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> Participants argued that the use of technology in essence supports the ethical, with it allowing repeated use, and they considered the lecturer giving beyond what is expected, when supporting its use.

The findings result in the **enhanced guideline**:

> The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, *should facilitate understanding whenever a user is in need of it*.

8.7.5.2.15 Pistic modality

Presentation of the codes

The codes reflecting the pistic modal aspect is shown in Table 8.37.

Table 8.37: List of codes pertaining to the pistic modal aspect, as applied to the interviews

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
Indications from other students regarding their progress on WhatsApp motivated me	[167] ●						1
Building trust among peers was supported by the WhatsApp group						[168] ●	1
I trusted that the lecturer or a peer would answer my questions on WhatsApp	[169] ●						1
Group work needs to be based on trust to perform well				[170] ●			1
We worked together as a group to meet requirements		[171] ●					1
Members in our project group did not contribute, but earned marks						[172] ●	1
The management of our documentation helped us to see progress			[173] ●				1
I made sure I understood what I did wrong in a test			[174] ●				1
The lecturer should provide a clear vision for a subject module				[175] ●			1
If you know where you going, you are motivated and focused			[176] ●				1

Codes for this modal aspect	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
SA&D allows me to look after myself, have a job					[177] O		1
SA&D may include more agile applications					[178] O		1
TOTAL	2	1	3	2	2	2	12

Analysis of the codes

Analysis is done with the **coded data being compared to the set of conceptual guidelines** obtained from aspectually analysing the three focal points in Table 8.38. The purpose of this step is to verify and refine this **conceptual guideline**:

> The focal points facilitate in-depth learning which should affect students beyond the classroom.

Table 8.38: Codes mapped to the conceptual guideline (pistic modality) in the context of the derived HCI focus

Applicable derived HCI focus aspect	Impact	
	In support	A problem
6) Capabilities performed according to user intentions	[167] Indications from other students regarding their progress on WhatsApp motivated me [168] Building trust among peers was supported by the WhatsApp group [169] I trusted that the lecturer or a peer would answer my questions on WhatsApp	- -

Participants reported a sense of belonging and trust that was facilitated by the technology tools. It motivated them. Code occurrences 167-169 refer.

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[177] [P] Maybe in a broader sense where this leads to me being able to look after myself, have a job, have a place (to stay), in a broader sense. But, in this sense … [I] Maybe pistic, because it looks at you vision of the future? [P] Ja [Yes], ja, ja, my vision for the future, Ja [Yes]. [I] So you say your studies, would you say there is a direct link between SA&D and what you are doing now in your job environment? [P] Definitely, … definitely. [I] So, uhm, how can I put it … do you feel that while doing the subject, you related to it because you felt that it's going to help you in a future job? [P] Ja [Yes], ja, ja, ja. I saw the link in a sense between the subject and what I expected for a job one day definitely, Ja [Yes], I saw that, and, Ja [Yes], it was something I enjoyed, I enjoyed the concepts and stuff. [I] The techniques that we worked with, the modelling? [P] Ja [Yes], it made sense to me. [I] Your job currently is programming, but do you have to do SA&D to get to your final product? Is it done on a daily basis? [P] Ja [Yes], I would not say on a daily basis, directly, but when we start a new project, we go through the motions. Unfortunately not as … thorough as I would like. But we do it.

[178] [P] Maybe the way we did it and the way it works in our job now is more of an agile type of thing. [I] Ja [Yes], ja. So you are more object-oriented, I think, that is my perception, while we did a lot of structured SA&D – with a little bit of object-orientation, while in your job it's more object-oriented. [P] Ja [Yes], and more agile. [I] So, it's smaller projects. [P] Smaller projects. Plan the project. Do it. Management. Criticize it and whatever. So, there is not a lot of time between development and production. It can be a week, even days. [I] It depends on the size. [P] Where this was more structured and it felt like we designed large parts of the system. Then coded that.

The findings following from the analysis

The **suggested modality guideline amendment** reads as follows:

> Participants related an atmosphere of belonging and trust that was facilitated by the use of the focal points, which motivated them.

The findings result in the **enhanced guideline**:

> Technology tools should facilitate in-depth learning which should affect students **in the classroom**, as well as beyond the classroom **in the workplace**.

The third part of the code table involves Improvements suggested and advice given.

8.7.5.3 Improvements suggested and advice given

This part of the code table involves ***grouping of data, and applying abstraction*** once more, as was done in Chapter 5 and in Section 8.7.5.1, specifically pertaining to the last two questions asked:

- Which improvements can you suggest for SA&D?
- What advice do you have for SA&D students starting the subject modules?

It had the purpose to form themes from categories that extend meaning regarding the research. Three themes with its associated categories and the codes associated per category is presented as network diagrams in Figure 8.6 to Figure 8.7. The intention of the presentation, analysis and findings of this section, is to investigate the problem solving part of this AR intervention, therefore to determine how future newcomer students may be emancipated to reach their full potential.

8.7.5.3.1 Presentation of the codes

The codes are presented in Table 8.39.

Table 8.39: List of codes regarding improvements and advice to new SA&D students, applied to the interviews done with participants

Codes per question	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
Suggested SA&D improvements							
The slides should be made available		[179]●					1
Make more videos, especially difficult theory concepts			[180]●				1

Codes per question	Participant						Code tally
	P1	P2	P3	P4	P5	P6	
Provide continuous information on what is happening in SA&D				181●			1
Class work should contribute to the participation mark				182●			1
The videos may be expanded, especially on Object-Orientation concepts					183●		1
An analogy representing the SDLC may facilitate the understanding of new SA&D students						184●	1
Soft skills such as facilitation may be supporting our future jobs						185●	1
TOTAL	0	1	1	2	1	2	7
Advice to new SA&D students							
The SA&D content represents skills used in the workplace						186●	1
Do not listen to other people, and make up your own mind regarding SA&D				187●			1
Keep a positive outlook					188●		1
Do not get overwhelmed initially, give yourself time to make sense of SA&D				189●			1
Work hard on your assignments and use the material in the group project				190●			1
Accomplish weekly project tasks		191●					1
Group work is key, do your part to learn			192●				1
Ask if you do not understand – peers and the lecturer			193●				1
Use tools in SA&D you learn about in other subjects			194●				1
Work hard and you will have success					195●		1
TOTAL	0	1	3	3	2	1	10

8.7.5.3.2 Analysis of the codes

The codes reflecting modalities reflected in Section 8.7.5.2 which did not pertain to the three focal points, is now analysed. Related codes which belong together to describe a phenomenon, were grouped to form categories. The construction of the description was adjusted to fit in with other descriptions identifying a category and represented as network diagrams as shown in Figure 8.6 and Figure 8.7. In a number of instances, codes listed under the modal aspects which relate to the three categories discussed here, have been repeated as codes.

With the purpose to tap into the hope and aspirations of new SA&D students, participants were asked to give advice to new SA&D students, anticipating that they will focus on the path they took successfully, or the path they wish they took – in order to be more successful in SA&D. Their recommendations may be used to make students new to SA&D, aware of potholes on the road to success. When analysing participants' conversations regarding the fifteen modalities, much information is found that may be categorised under the theme of "*What to be aware of*" – in Figure 8.6.

Suggestions include:

1. Skills learned in "*SA&D, links with the workplace*" (P6), and the use of skills obtained in other subjects, in SA&D (P3). These codes were categorised under making students new to SA&D aware that there is a direct link between what they learn, and eventually use in the workplace, and that this link is simulated in the subject modules (P4). Participants specifically indicated project work (P4, P6), tools researched in class (P6), and their textbook (P6) as useful in the work environment.
2. The category "*keeping a positive mind-set"* groups the codes having a positive outlook (P5), not to listen to rumours, but to make up your own mind regarding SA&D (P4) and be open to change (P4), to take your time to make sense of SA&D (P2, P4), to use the structure of the subject to guide you (P4, P6), and to ask peers or your lecturer should there be anything you do not understand (P3). It also requires the lecturer to facilitate the perspective of a student assistant (P6), make use of an analogy to make it easier to understand the SDLC (P6), motivate why activities need to be performed (P3, P4, P6), and to use trackers and statistics to motivate students (P1). Lastly, the powers that be need to ensure that students have what they need to study IT (P4, P6).
3. The requirement of "*hard work*" was considered important among the participants with group work listed as important to contribute to – to ensure one's own learning (P2, P3, P4, P5, P6), the link between assignments and the group project is highlighted (P4), as is the importance of accomplishing weekly project tasks (P2, P3), and the fact that success is based on hard work (P5). Preparing for assessments with care, is considered important (P2, P5), and to do that one needs to be well rested (P3).

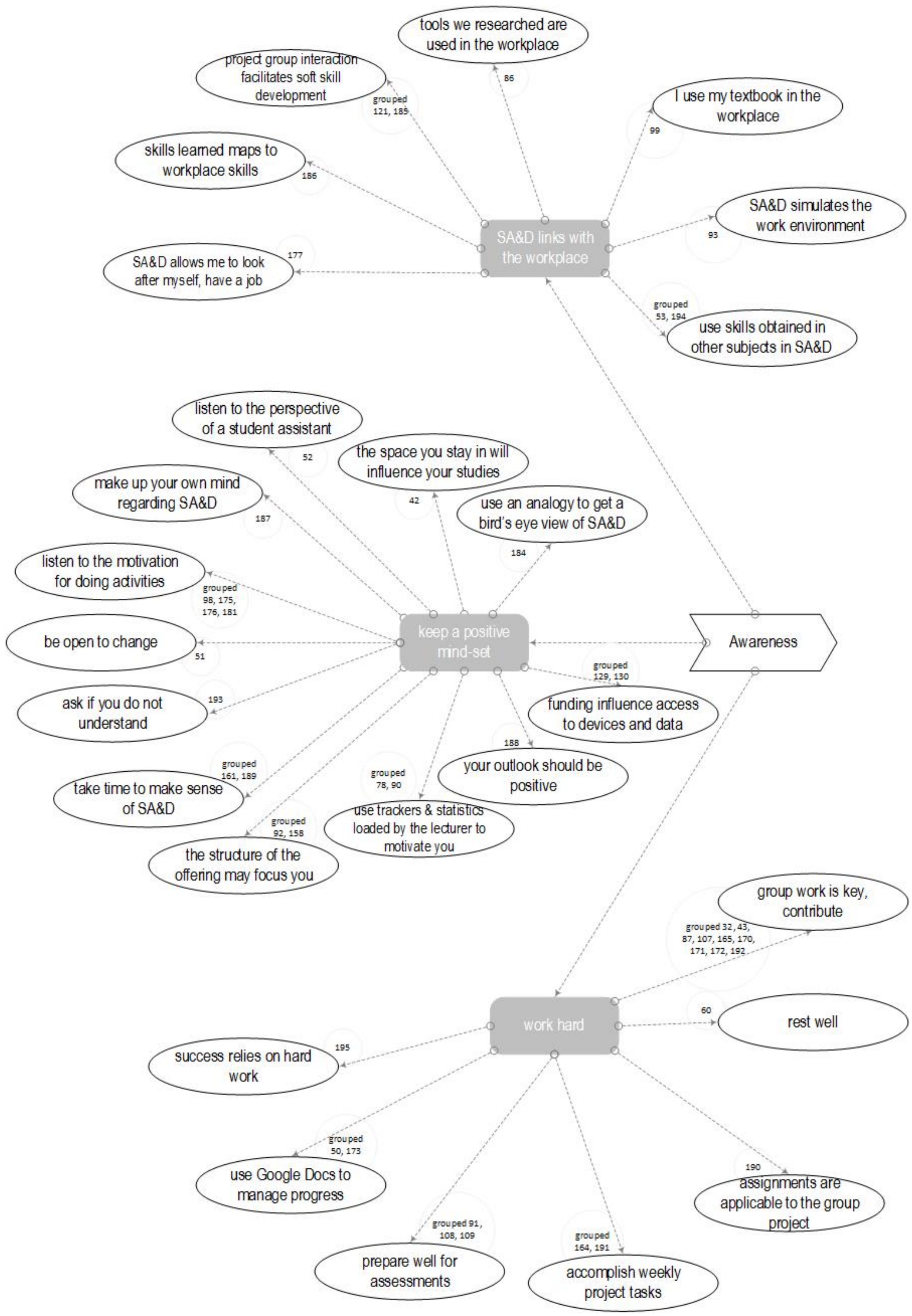


Figure 8.6: Network diagram showing theme "What to be aware of", with its categories, each with grouped codes

The theme "*What to be aware of*" (Figure 8.6) impacts three modalities:

- The category "*SA&D links with the workplace*" is relevant to the ***aesthetic***, since the tools used in SA&D extends to facilitate understanding in the workplace as well.

- The category "*Keep a positive mind*-set", supports the ***juridical***, where the participants related nuggets of wisdom regarding what helped them to stay positive, which enabled them to make use of the resources that suited them, and be successful.
- The category "*SA&D links with the workplace*", relates to the *pistic* with tools used beyond the classroom into a future career.

During the course of the interviews, electronic tools beyond the three focal points were mentioned, along with tools which are not electronic. These include the group project (P4, P6), past papers (P3), preparing for class (P3), self-developed material (P3, P5, P6), the outcomes per study unit (P6), plagiarism software (P6), the textbook (P5), slides (P2, P5), and assessments (P2, P3, P5) – as represented in Figure 8.7.

The theme "*Helpful tools*" (Figure 8.7) impacts three modalities:

- Tools listed not only stretch beyond the three focal points, but also beyond technology, extending the repertoire of tools to choose from – in which to ***logically*** consider where to find answers to questions, and ***logically*** consider answers supplied by peers.
- Technology tools beyond the three focal points, as well as non-technology tools, supports the ***formative***, with participants each voicing a personal approach to mastering the material. The current **enhanced guideline** is:

  > The integration of **electronic** tools may support the **planning for learning and** guidance which should be provided by *an* educational technology tool.

- Technology tools beyond the three focal points, as well as non-technology tools, supports the ***pistic*** where the value of the tools in various contexts, are highlighted.

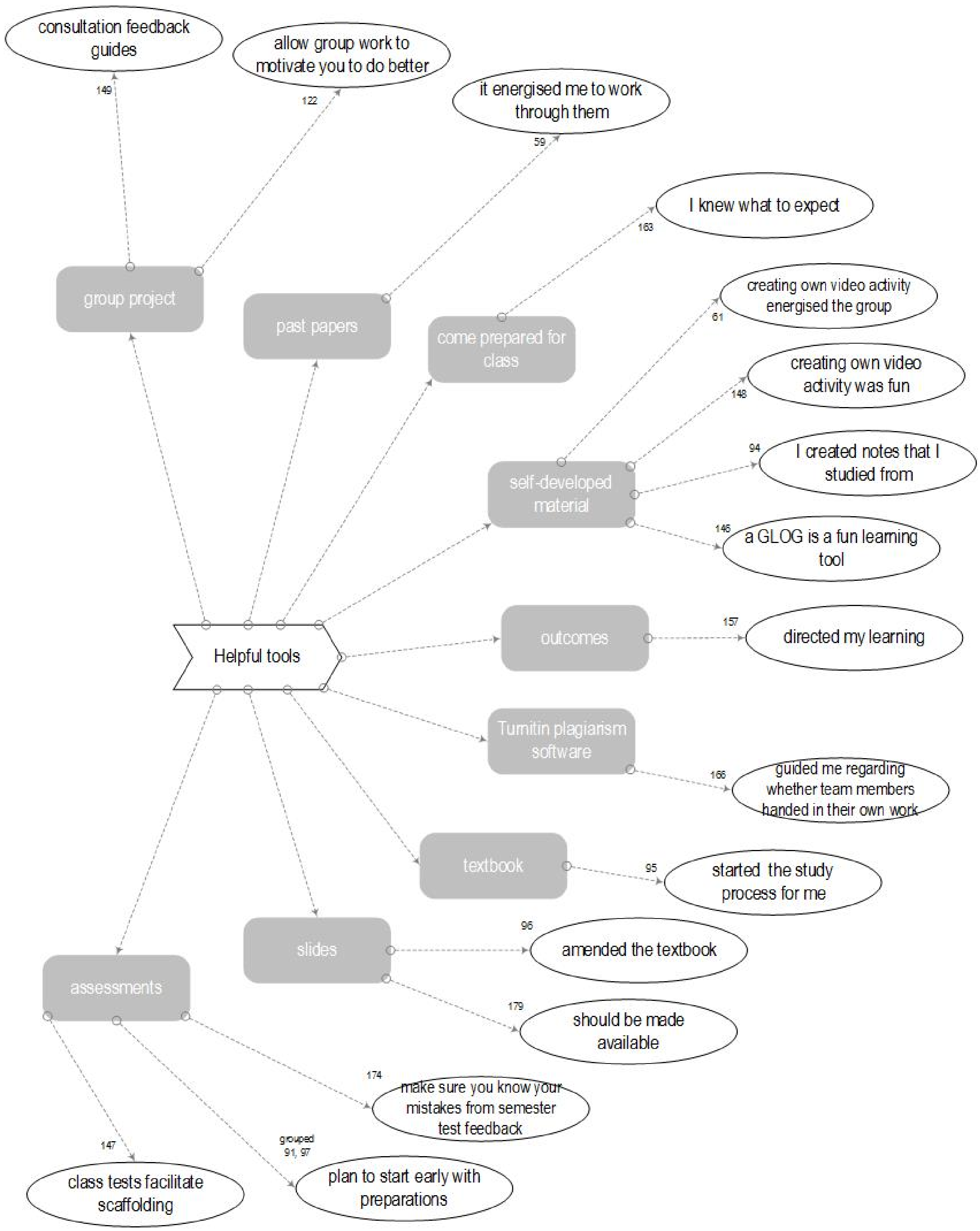


Figure 8.7: Network diagram showing theme "Helpful tools", with its categories, each with grouped codes

The last theme identified, is that of "*Future improvements*", with suggestions of having less assignments to do (P2), letting class work count towards the participation mark (P4), making provision for the analysis and design of agile applications (P5), and the expansion of the available videos (P3, P5) – represented in Figure 8.8.

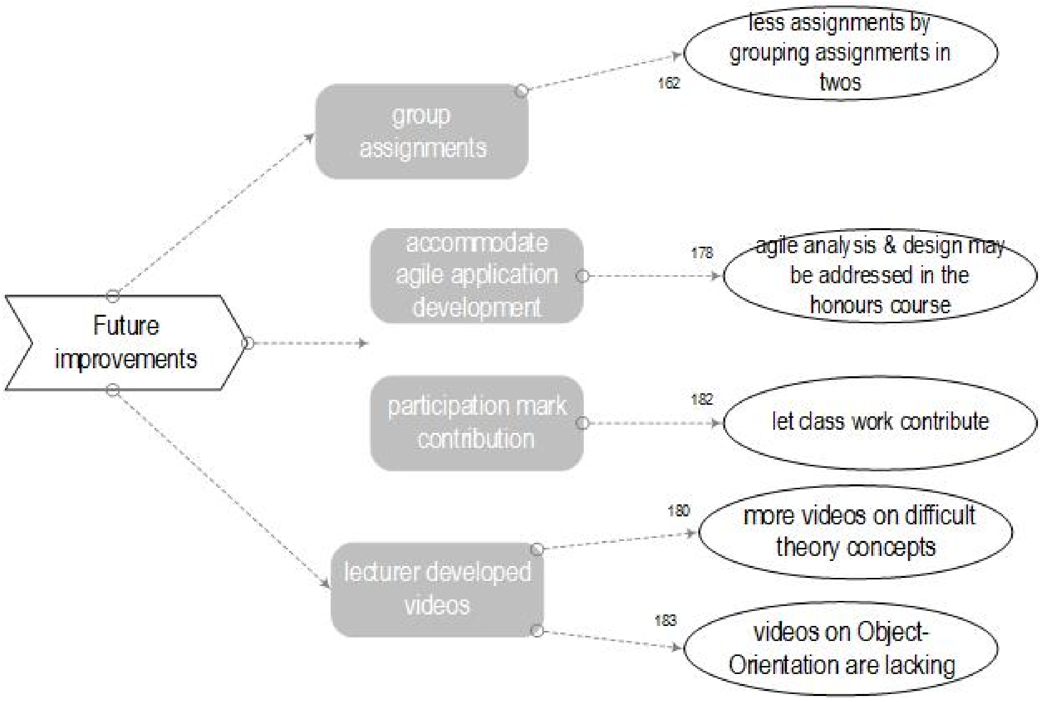


Figure 8.8: Network diagram showing theme "Improvements", with its categories, each with grouped codes

8.7.5.3.3 Findings following from the analysis

The formative modality guideline amendment is improved:

> A variety of technology and non-technology tools should be provided to use – to allow a student to plan, and be guided to fully understand a concept – in a way determined by individual preferences.

The findings result in the **enhanced guideline**:

> The integration of **electronic and other** tools may support the **planning for learning and** guidance which should be provided by *an* educational technology tool.

Participants relayed advice to students starting with SA&D – from the perspective of someone who has already been there – with the purpose to emancipate the new SA&D student and to enable development to the student's full potential. This finding relates to the problem solving aspect of this AR cycle. The theme has been named "What to be aware of", and includes three categories:

1. "*SA&D, links with the workplace*" – this knowledge may enlighten and motivate the new student and should be emphasized. Participants indicated the simulation of the work environment through project work, and the textbook to extend into their work environment.
2. "K*eeping a positive mind-set",* is listed as very important to ensure success in SA&D. These subject modules challenge the student, but the challenge is intended to prepare the students with new skills valuable in the workplace. A number of tools have been listed that may guide students, depending on personal preferences.
3. The requirement of "*hard work*" is in the end what is required to take up the challenge presented by a challenging subject. Key issues to address are acknowledging the link between assignments and the group project, complete weekly project tasks, to preparing for assessments diligently, and to ensure one is well rested.

In a last theme, that of "*Future improvements*", suggested that less assignments may impact the workload, that class work should count towards the participation mark, to also make provision for the analysis and design of agile applications (in addition to structured analysis & design that is already addressed), and the expansion of the available videos.

Reporting and ***reflection on trustworthiness of the data analysis*** is done in the section on learning specified below.

8.8 AR CYCLE N – LEARNING SPECIFIED

At the start of this chapter, it was forestalled that learning specified will focus on solving a real-world problem (P) of teaching the subject modules of SA&D to **newcomer** IT students. The focus was on the three focal points of this study, which include instructional design using SMARTguides, formative guidance using Videos, and summative assessment using WhatsApp that had the purpose to emancipate newcomer students – to enable them to reach their full potential (M_{PS}). Feedback from participants will facilitate the future instructional design to enable emancipation. The focus will be in the areas of "*Value of the focal points*", "*What to be aware of*", how to "*Keep a positive mind-set*", the requirement of "*hard work*", and being conscious of potential "*Future improvements*". The AR method was applied to the problem. The HCI principles and the AEF (M_R), based on the philosophy of Dooyeweerd, guided interviews. The primary goal of this chapter, namely to verify and refine the conceptual guidelines formulated from literature, was achieved – through the successful application of an AR cycle.

From the mapping that was done on the conceptual guidelines – in Table 8.3, the enhanced HCI-AEF guidelines are formulated – in Table 8.40. The formulation takes the impact into consideration, in the case of benefits, and challenges or consequences presented. In the formulation of the enhanced HCI-AEF guidelines, the focus moved from the three focal points to technology tools as possible implementations. The intention is to improve the real-world environment regarding the three focal points, as well as future technological implementations.

Table 8.40: Enhanced HCI-AEF guidelines

Derived HCI focus	Enhanced modality in support of the derived HCI focus
1) Consistency and familiarity facilitate learning	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.
2) Guide users by using physical and logical constraints	Q: Only the MIMA groups have a size limitation in terms of the members accommodated. In all *technology tools* a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number. Examples should cover from the very simple to complex issues.
	Sp: With all types of devices considered, special attention should be given to mobile devices – to accommodate technology tools. Because of its small screens, it is imperative to compile compact chunks of information.
	O: Units of material should be compact, *to present contained information designed to engage,* and to allow for breaks.
	F: The integration of electronic and other tools may support the planning for learning and guidance which should be provided by *an* educational technology tool.
	Ec: Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.
	J: Users should want to access an educational tool *which* fulfils its purpose and provide guidance, information, motivation *and/*or clarity *according to the immediate need* – to ensure that what is due for all is made available.
3) Flexibility allows for effective use	So: Of the three focal points, only the WhatsApp group supports social interaction. The social side should be moderated in an academic implementation. *All technology tools* should *accommodate* a diversity of cultures of its users to ensure widespread use.
	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, *should facilitate understanding whenever a user is in need of it*.
4) Prevent mistakes, or allow for its clear identification	Li: In the case of all three focal points, engagement with content relies on the lingual. *All possible communication mechanisms (pictures, videos, etc.) should be encouraged*, *to convey the intended message and to ensure consistency*.
	A: Technology tools should be designed in a way which is aesthetically pleasing and to facilitate understanding.

Derived HCI focus	Enhanced modality in support of the derived HCI focus
5) Allow for recovery from mistakes by returning to a previous state	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, *should facilitate understanding whenever a user is in need of it*.
6) Capabilities performed according to user intentions	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, *should facilitate understanding whenever a user is in need of it*.
	Pi: Technology tools should facilitate in-depth learning which should affect students in the classroom, as well as beyond the classroom in the workplace.
7) Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses	Ph: The use of tools may energise users, while its availability acts as a backup support. In addition, it should support the visual, and the auditory by presenting clear displays and sound.
	Se: Colour and sound, combined with a strong message which clearly conveys the purpose of a concept, may facilitate understanding. An academic focus should be encouraged.
	Lo: The coordination of tools should *allow* the logical progression of the presentation of material according to the user's needs.
8) Timely communication of task status	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.
	Li: In the case of all three focal points, engagement with content relies on the lingual. *All possible communication mechanisms (pictures, videos, etc.) should be encouraged*, *to convey the intended message and to ensure consistency*.

Establish trustworthiness. The list of questions formulated above (Table 8.5), has been utilised to verify its implementation as seen in Table 8.41).

Table 8.41: Trustworthiness verification list used to guide content analysis

No.	Question to guide trustworthiness	Motivation with references
1	Is the process of analysis as well as the ensuing results described in enough detail?	Data analysis is broken down in §8.7.1, with results being highlighted by codes indicating problems and those in support of the use of technology.
2	Are the themes described by its categories, and categories by its codes?	Descriptions of themes, categories, and codes were done in §8.7.5 (illustrated by Figure 8.5, Figure 8.6 and Figure 8.7, and Table 8.8 to Table 8.23).
3	Do the groupings cover the data well?	Description of groupings was done in §8.7.5 (illustrated by Figure 8.5, Figure 8.6 and Figure 8.7), and the mapping of codes to initial guidelines (illustrated by Table 8.9 to Table 8.23).
4	Are the context, the participants, data collection, and analysis process described thoroughly?	Descriptions of the context are found in §8.4, §8.5 and §8.6, participants in §5.7.4 (illustrated by Table 8.7), data collection and the analysis process in §8.7.3 (illustrated by Table 8.7). All code instances were numbered to ensure traceability.
5	Are citations from the empirical data included without pointing to participants' identity?	Inclusion of citations from the empirical data are included as footnotes and linked with codes and code instances in §8.7.5 (illustrated by Table 8.10 to Table 8.23).

No.	Question to guide trustworthiness	Motivation with references
6	Was content validation done? A number of content validation techniques are available, including face validity, and the use of agreement coefficients. Options for seeking agreement may utilise a panel of experts, or dialogue among co-researchers.	Content validation was conducted through dialogue between the researcher and her study leader.

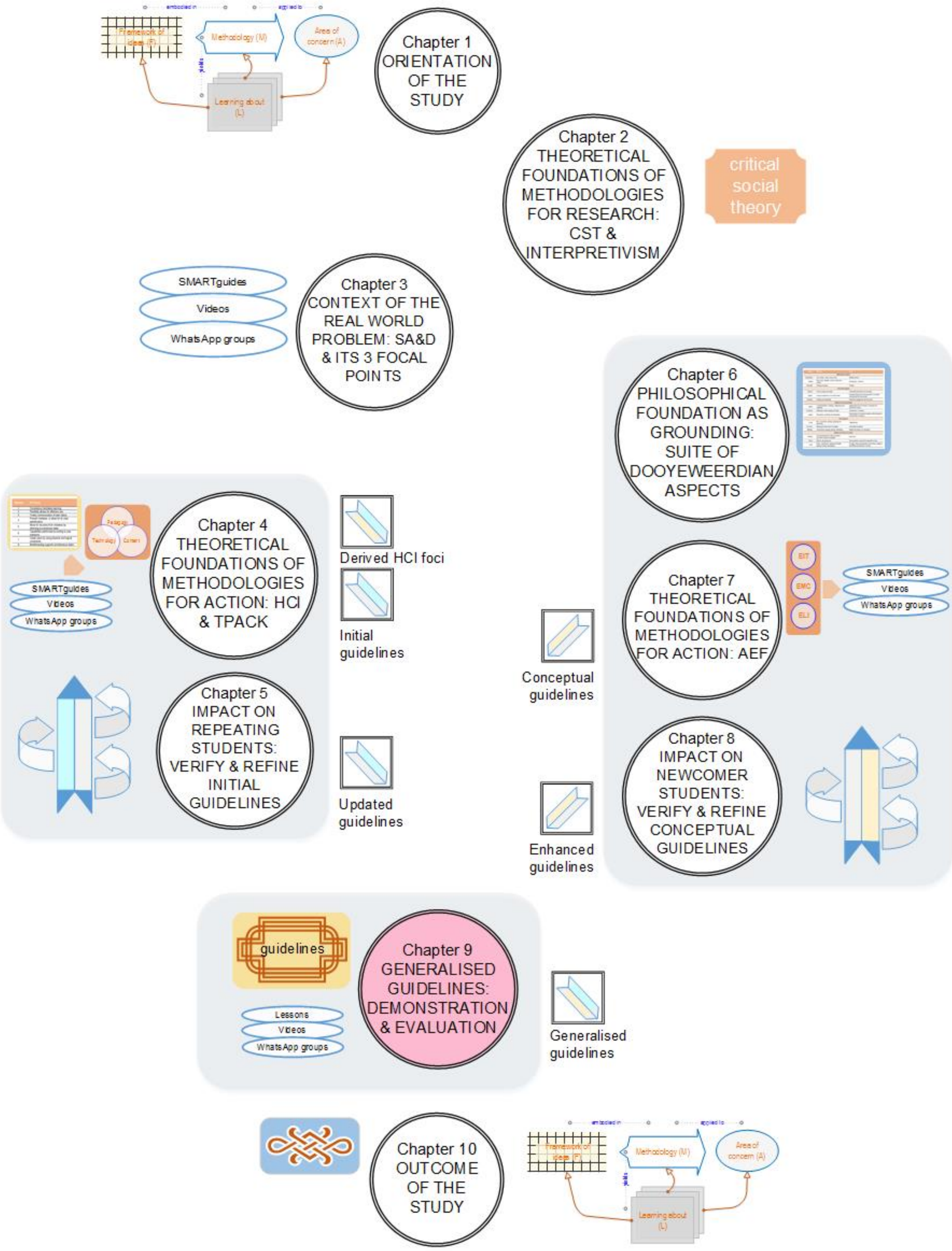
8.9 SUMMARY

The purpose of this chapter was to apply the method of AR to represent the evolution of the SA&D subject modules over a period of time. The second empirical objective (E02) were addressed in this chapter, namely to apply AR as five-step method to direct the verification of the conceptual guidelines that was extracted from the previous chapter. The focus was on the experience of students as first time enrolments of the first SA&D subject module and used the three focal points.

Five steps of AR were followed in this intervention, comprising of the implementation of three focal points in classes presented to newcomer students. The purpose was to emancipate these students, to enable them to reach their full potential. A second part of the intervention, is guided by the derived HCI foci and the AEF (Basden, 2008; Basden, 2018). The use of MAKE interviews facilitated the elicitation of knowledge participants gained while studying SA&D (Winfield, 2000). The purpose is to verify and refine conceptual guidelines in order to obtain enhanced guidelines.

The following chapter will use the updated HCI-TPACK guidelines obtained from Chapter 5, as well as the enhanced HCI-AEF guidelines as output from this chapter, to extract generalised guidelines. A demonstration based on these guidelines will then be prepared and presented to current SA&D students to allow its evaluation and validation.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



9 GENERALISED GUIDELINES: DEMONSTRATION & EVALUATION

9.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education, based on human computer interaction principles, from a Dooyeweerdian perspective.

In order to achieve this primary objective, this chapter integrates the two sets of guidelines obtained from the empirical objectives; the updated HCI-TPACK guidelines obtained from initial guidelines, and the enhanced HCI-AEF guidelines obtained from conceptual guidelines. Extracted generalised guidelines are the result of this integration. The generalised guidelines are then used in the improvement of the three focal points and also utilised in instructional design. The improved material and design is then demonstrated to the current contingent of systems analysis and design students to allow its evaluation and ultimately, its validation. Action research, as five-step method, was used to guide this process (E03).

In the subsequent sections, the focus of this chapter is firstly on the elements that are relevant to this study (§9.2). Generalised guidelines are extracted from the updated HCI-TPACK guidelines and the enhanced HCI-AEF guidelines (§9.3). A last action research cycle is performed, with background information (§9.4) and the five steps of diagnosis (§9.5), planning for action (§9.6), taking action (§9.7), evaluation (§9.8), and learning specified (§9.9), is presented in the context of all systems analysis and design students. The final section concludes the chapter with a summary (§9.10).

9.2 ELEMENTS RELEVANT TO THIS STUDY

Throughout this study, the refined Checkland and Holwell (1998b:23) model is directing the research plan for this study (Figure 9.1). The focus of this chapter is on extracting generalised guidelines (C) in the context of using technology to teach technology subjects (A). The generalised guidelines are then used to guide the future offerings of systems analysis and design (SA&D).

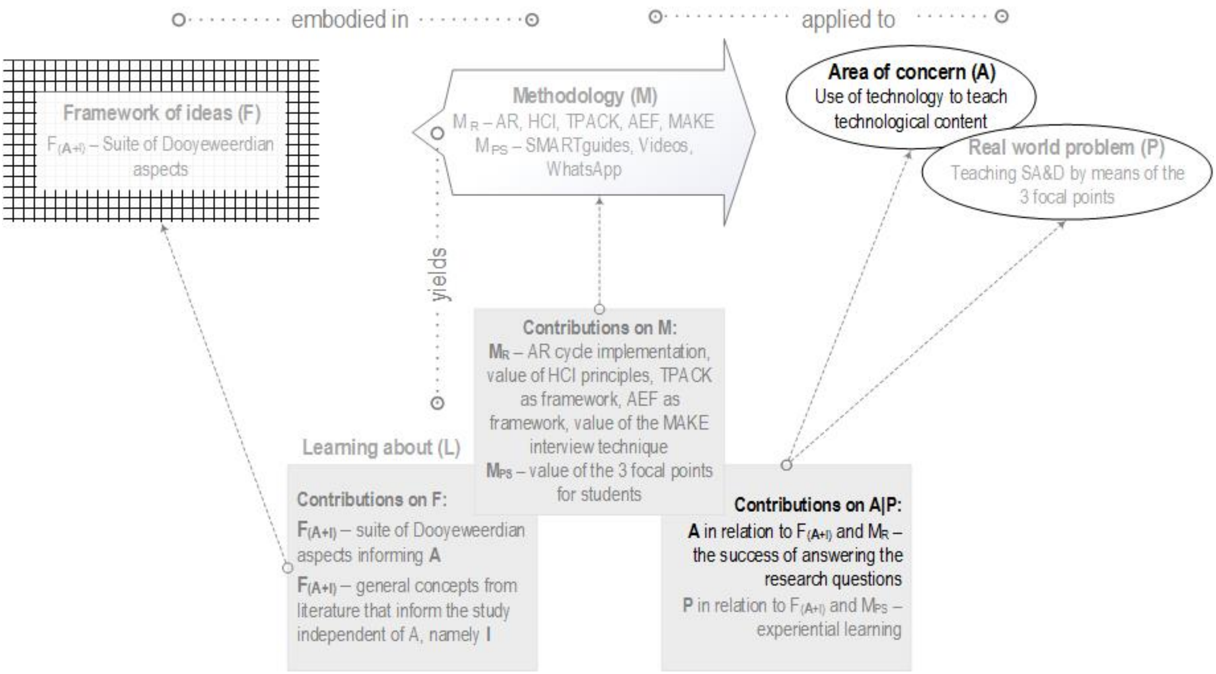


Figure 9.1: The elements relevant to this chapter

Changes are planned to the instructional design of SA&D, as well as the three focal points, namely SMARTguides to guide instructional design, Videos for formative guidance, and WhatsApp groups guiding summative assessment (M_{PS}). The purpose of changes is the emancipation of students to facilitate a process for them to reach their full potential. A demonstration of the changes to the three focal points are shown to a group of students selected as participants.

9.3 GENERALISED GUIDELINES

The generalised guidelines are now extracted from the updated HCI-TPACK guidelines obtained from initial guidelines, and enhanced HCI-AEF guidelines obtained from conceptual guidelines.

9.3.1 Updated HCI-TPACK guidelines

The updated HCI-TPACK guidelines are shown in Table 9.1. It has been discussed in full in Chapter 5, and shown in Table 5.13. The focus is on the spheres of technology, pedagogy, and content. Initially the derived HCI foci had been grouped according to the spheres. This occurred in Chapter 4, Table 4.8, and resulted in the initial guidelines. An update emphasis has been introduced to highlight changes made to the initial guidelines to extract the updated guidelines and is retained here: a guideline which have been changed, is shown in *italics*, and one amended is shown in **bold**.

Table 9.1: Updated HCI-TPACK guidelines

Knowledge	Guideline
Content	Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge to address more complex problems.
Pedagogy	The identification of teaching (and learning) approaches is paramount in guiding the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.
Technology	*The inclusion of technology tools requires ensuring its accessibility and therefore guidance in its use, and support regarding its download to a variety of platforms.* Additional non-technical measures should be considered when utilising technology tools not intended for teaching and learning. The HCI foci listed are applicable to the technology sphere.
	HCI focus
	Consistency and familiarity facilitate learning (1). The selection of technology tools should favour familiarity. In combination with simplicity and consistency regarding look & feel, movement, uses, speed of operation, and status indication within a technology tool, to which the user is allowed to become familiar with in a short timeframe.
	Flexibility allows for effective use (3). Flexibility regarding access to learning material is important, and the technology tools should be accessible via a variety of platforms (mobile, laptop, desktop) and modes (online, offline; sequentially and direct). Knowledge of the underlying technology tool is also necessary to ensure its flexibility of use.
	Prevent mistakes, or allow for its clear identification (4). The use of technology tools should be directed with clear information *included in the tool*. Additional non-technical measures may be necessary when utilising technology tools not intended for teaching and learning – to prevent mistakes.
	Allow for recovery from mistakes by returning to a previous state (5). It should be quick and easy to recover from mistakes occurring with regard to the use of a technology tool. Mistakes include the corruption of either the application, or a file (in the case of a video), and sending a message to the wrong group, or with the wrong intention.
	Capabilities performed according to user intentions (6). A technology tool designed or selected to guide teaching and learning should allow a user to use it to the user's intentions. In addition, when more than one technology tool is made available, a user should be able to use the ones fit for a task.
	Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7). A task a user needs to perform, should involve a dialogue thread. The improvement of computer interfaces for use by humans should be based on measuring human perception, where humans perceive their environment through their senses (see, hear, touch, smell, taste). In an educational context technology tools should support non-technology tools in achieving a goal.
	Timely communication of task status (8). Timely communication of task status should be supported by technology tools. In addition, it is important to create awareness to be sensitive towards status feedback regarding the technology tools.
Pedagogy-content	Content should be taught in a way which conveys the message of the material learned. Typically, a particular technology tool would support only a part of the overall approach. In an academic context, students should be made aware of the existence of technology tools, the value of each tool, and how to use it in conjunction with non-technical tools.
	HCI focus
	Guide users by using physical and logical constraints (2). The use of computer power and availability to guide user progression in using a technology tool.

Knowledge	Guideline
Technology-content	Although technology typically does not constrain the transfer of large amounts of material, *the presentation of small portions of interactive in-context material to direct learning when needed, should be the focus when using it for teaching and learning purposes.*
Technology-pedagogy	Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.
Technology-pedagogy-content	In support of a lecturer, technology should be a channel for content presented in a way through which students will best internalise concepts.

9.3.2 Enhanced HCI-AEF guidelines

The enhanced HCI-AEF guidelines are shown in Table 9.2. It had been discussed in Chapter 8, and shown in Table 8.40. The three spheres of the aspectual engagements framework (AEF) are underlying the guidelines directed by the suite of 15 Dooyeweerdian modalities. These modalities have been mapped to the derived HCI foci in Chapter 7, to obtain conceptual guidelines. An enhance emphasis has been introduced to highlight changes, which is retained here: a guideline that have been changed, is shown in *italics*, and one amended is shown in **bold**.

Table 9.2: Enhanced HCI-AEF guidelines

Derived HCI focus	Enhanced modality in support of the derived HCI focus
1) Consistency and familiarity facilitate learning	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.
2) Guide users by using physical and logical constraints	Q: Only the MIMA groups have a size limitation in terms of members accommodated. In all *technology tools* a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number. **Examples should cover from the very simple to complex issues.**
	Sp: With all types of devices considered, special attention should be given to mobile devices – **to accommodate technology tools**. Because of its small screens, it is imperative to compile compact chunks of information.
	O: Units of material should be compact, *to present contained information designed to engage,* **and to allow for breaks.**
	F: The integration of **electronic and other** tools may support the **planning for learning and** guidance which should be provided by *an* educational technology tool.
	Ec: Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.
	J: **Users should want to access** an educational tool *which* fulfils its purpose and provide guidance, information, **motivation** *and/*or clarity *according to the immediate need* – to ensure that what is due for all is made available.

<table>
<tr><th>Derived HCI focus</th><th>Enhanced modality in support of the derived HCI focus</th></tr>
<tr><td rowspan="2">3) Flexibility allows for effective use</td><td>So: Of the three focal points, only the WhatsApp group supports social interaction. The social side should be moderated in an academic implementation. All technology tools should accommodate a diversity of cultures of its users to ensure widespread use.</td></tr>
<tr><td>Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.</td></tr>
<tr><td rowspan="2">4) Prevent mistakes, or allow for its clear identification</td><td>Li: In the case of all three focal points, engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.</td></tr>
<tr><td>A: Technology tools should be designed in a way which is aesthetically pleasing and to facilitate understanding.</td></tr>
<tr><td>5) Allow for recovery from mistakes by returning to a previous state</td><td>Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.</td></tr>
<tr><td rowspan="2">6) Capabilities performed according to user intentions</td><td>Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.</td></tr>
<tr><td>Pi: Technology tools should facilitate in-depth learning which should affect students in the classroom, as well as beyond the classroom in the workplace.</td></tr>
<tr><td rowspan="3">7) Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses</td><td>Ph: The use of tools may energise users, while its availability acts as a backup support. In addition, it should support the visual, and the auditory by presenting clear displays and sound.</td></tr>
<tr><td>Se: Colour and sound, combined with a strong message which clearly conveys the purpose of a concept, may facilitate understanding. An academic focus should be encouraged.</td></tr>
<tr><td>Lo: The coordination of tools should allow the logical progression of the presentation of material according to the user's needs.</td></tr>
<tr><td rowspan="2">8) Timely communication of task status</td><td>K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.</td></tr>
<tr><td>Li: In the case of all three focal points, engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.</td></tr>
</table>

The two sets of guidelines, shown above, is now combined to form generalised guidelines.

9.3.3 Extracted generalised guidelines

The generalised guidelines are shown in Table 9.3. The groupings suggested by the TPACK framework direct the guidelines, with some spheres containing the derived HCI foci that has been updated. In addition, the enhanced guidelines support the updated derived HCI foci. All update and enhance emphases have been removed here, and the guidelines have been numbered to facilitate the reference to an individual guideline when the focal points are demonstrated in Section 9.6.

Table 9.3: Generalised guidelines

<table>
<tr><th>No.</th><th>Knowledge</th><th colspan="2">Guideline</th></tr>
<tr><td>1</td><td>Content</td><td colspan="2">Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge to address more complex problems.</td></tr>
<tr><td>2</td><td>Pedagogy</td><td colspan="2">The identification of teaching (and learning) approaches is paramount in guiding the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.</td></tr>
<tr><td>3</td><td rowspan="8">Technology</td><td colspan="2">The inclusion of technology tools requires ensuring its accessibility and therefore guidance in its use, and support regarding its download to a variety of platforms. Additional non-technical measures should be considered when utilising technology tools not intended for teaching and learning. The HCI foci listed are applicable to the technology sphere.</td></tr>
<tr><td rowspan="2">3.1</td><td>HCI focus</td><td>Enhanced guideline</td></tr>
<tr><td>Consistency and familiarity facilitate learning (1).
The selection of technology tools should favour familiarity. In combination with simplicity and consistency regarding look & feel, movement, uses, speed of operation, and status indication within a technology tool, to which the user is allowed to become familiar with in a short timeframe.</td><td>K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.</td></tr>
<tr><td>3.2(1)</td><td rowspan="2">Flexibility allows for effective use (3).
Flexibility regarding access to learning material is important, and the technology tools should be accessible via a variety of platforms (mobile, laptop, desktop) and modes (online, offline; sequentially and direct). Knowledge of the underlying technology tool is also necessary to ensure its flexibility of use.</td><td>So: Of the three focal points, only the WhatsApp group supports social interaction. The social side should be moderated in an academic implementation. All technology tools should accommodate a diversity of cultures of its users to ensure widespread use.</td></tr>
<tr><td>3.2(2)</td><td>Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.</td></tr>
<tr><td>3.3(1)</td><td rowspan="2">Prevent mistakes, or allow for its clear identification (4).
The use of technology tools should be directed with clear information included in the tool. Additional non-technical measures may be necessary when utilising technology tools not intended for teaching and learning – to prevent mistakes.</td><td>Li: In the case of all three focal points, engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.</td></tr>
<tr><td>3.3(2)</td><td>A: Technology tools should be designed in a way which is aesthetically pleasing and to facilitate understanding.</td></tr>
<tr><td>3.4</td><td>Allow for recovery from mistakes by returning to a previous state (5).
It should be quick and easy to recover from mistakes occurring with regard to the use of a technology tool. Mistakes include the corruption of either the application, or a file (in the case of a video), and sending a message to the wrong group, or with the wrong intention.</td><td>Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.</td></tr>
</table>

No.	Knowledge	Guideline	
3.5(1)		Capabilities performed according to user intentions (6). A technology tool designed or selected to guide teaching and learning should allow a user to use it to the user's intentions. In addition, when more than one technology tool is made available, a user should be able to use the ones fit for a task.	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.
3.5(2)			Pi: Technology tools should facilitate in-depth learning which should affect students in the classroom, as well as beyond the classroom in the workplace.
3.6(1)		Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7). A task a user needs to perform, should involve a dialogue thread. The improvement of computer interfaces for use by humans should be based on measuring human perception, where humans perceive their environment through their senses (see, hear, touch, smell, taste). In an educational context technology tools should support non-technology tools in achieving a goal.	Ph: The use of tools may energise users, while its availability acts as a backup support. In addition, it should support the visual, and the auditory by presenting clear displays and sound.
3.6(2)			Se: Colour and sound, combined with a strong message which clearly conveys the purpose of a concept, may facilitate understanding. An academic focus should be encouraged.
3.6(3)			Lo: The coordination of tools should allow the logical progression of the presentation of material according to the user's needs.
3.7(1)		Timely communication of task status (8). Timely communication of task status should be supported by technology tools. In addition, it is important to create awareness to be sensitive towards status feedback regarding the technology tools.	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.
3.7(2)			Li: In the case of all three focal points, engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.
4	Pedagogy-content	Content should be taught in a way which conveys the message of the material learned. Typically, a particular technology tool would support only a part of the overall approach. In an academic context, students should be made aware of the existence of technology tools, the value of each tool, and how to use it in conjunction with non-technical tools. The HCI foci listed are applicable to the pedagogy-content intersection.	
		HCI focus	**Enhanced guideline**
4.1(1)		Guide users by using physical and logical constraints (2). The use of computer power and availability to guide user progression in using a technology tool.	Q: Only the MIMA groups have a size limitation in terms of members accommodated. In all technology tools a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number. Examples should cover from the very simple to complex issues.
4.1(2)			Sp: With all types of devices considered, special attention should be given to mobile devices – to accommodate technology tools. Because of its small screens, it is imperative to compile compact chunks of information.
4.1(3)			O: Units of material should be compact, to present contained information designed to engage, and to allow for breaks.

No.	Knowledge	Guideline	
4.1(4)			F: The integration of electronic and other tools may support the planning for learning and guidance which should be provided by an educational technology tool.
4.1(5)			Ec: Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.
4.1(6)			J: Users should want to access an educational tool which fulfils its purpose and provide guidance, information, motivation and/or clarity according to the immediate need – to ensure that what is due for all is made available.
5	Technology-content	Although technology typically does not constrain the transfer of large parts of material, the presentation of small portions of interactive in-context material to direct learning when needed, should be the focus when using it for teaching and learning purposes.	
6	Technology-pedagogy	Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.	
7	Technology-pedagogy-content	In support of a lecturer, technology should be a channel for content presented in such a way through which students will best internalise concepts.	

With the generalised guidelines obtained, a final action research (AR) cycle for the combined (C) class, is implemented.

9.4 AR CYCLE C – BACKGROUND

With the two AR cycles for repeating and newcomer students completed, and the generalised guidelines extracted from the derived HCI foci – by applying the framework for technological pedagogical content knowledge (TPACK) interaction and the AEF, another AR cycle is implemented. A demonstration of the improved three focal points was prepared to enable the researcher to involve a group of students as participants selected from the SA&D 2019 class group, with the purpose to show them improvements to the focal points based on the research, and then to obtain their feedback. Changes were prompted by the generalised guidelines being applied to the three focal points. These changes have the ultimate purpose to emancipate students and guide them to reach their full potential.

In addition to the enhancement of the three focal points, the changes in the environment enabled a new implementation of the SA&D modules. With the North-West University (NWU) becoming a unitary university, the allowance for SA&D class time on the Vaal Campus (VC) was aligned with that of the Potchefstroom Campus in 2019. This change allocated four double periods, instead of the two which were available during preceding years. A request by the lecturer, was finally heard, and the additional time could be utilised fully.

In addition, the 2018 SA&D I repeater class became much bigger than previous years. A growth of 50% manifested. This occurrence was due to the #FeesMustFall movement of 2015, which lifted much of the academic financial constraints experienced by previously disadvantaged students. The bigger class made the use of games in the format it was conducted more difficult to implement.

These changes impacted SA&D profoundly, and as a result it was decided that the additional time allows for the repeating and newcomer groups to be combined as was the case before 2015. Both groups would then be privy to the work that was covered by the other group, in a formal setting. With the purpose to make this plan work, a few changes were implemented regarding the resources used in the instructional design of the modules:

- Class Work was retained from the AR Cycle N, but its focus changed to include possible test questions to be answered in class.
- A scenario, covered in a way supplemental instruction would be conducted, was introduced.
- Workshop sessions were designed to incorporate the Class Work material implemented in AR Cycle N.

A discussion, which explains the changes mentioned, follows in Section 9.5, Table 9.6.

The research question for this iteration is stated as:

How can the lecturer amend the three focal points, each with its particular niche in SA&D, to create a limber environment that will ensure that the combined class of repeating & newcomer students reach their potential?

Subsequently the five-step interactive AR process is used as research method in this chapter (Susman & Evered, 1978:588): the problem is diagnosed; a plan of action is compiled; action is taken; the action is evaluated; and learning is specified.

9.5 AR CYCLE C – DIAGNOSIS

Similar to the two AR cycles presented in Chapters 5 and 8, Churchman (1968:29) steers this demonstration in the diagnosis step. It includes five considerations of a system, in this instance the educational system of SA&D: purpose, environment, resources, components, and the management.

This section focuses on the instructional design of the SA&D module for a combined class of all students which is viewed as a "*system*" in the context of the systems approach. With this section building on the original context of the study (Chapter 3), Table 9.4 to Table 9.8 includes the contextual information from Table 3.1. The original table composition has been split into five tables, one for each consideration. Each consideration has been listed on a new page to make it easier to include the diagnoses of the two AR Cycles, R and N, from Chapters 5 and 8 (Table 5.1 & Table 8.1). The diagnosis of the current SA&D class for all students, is listed first.

Table 9.4: Churchman's considerations in diagnosing the instructional design of the classes of SA&D: purpose

<table>
<tr><th colspan="2">Diagnosing the instructional design of SA&D</th></tr>
<tr><td colspan="2">Purpose: the purpose of a system is described as the overall, measurable objective of the system. Churchman (1968:31) argues that the real objective is not always clear, and typically the objective is that which will not be jeopardised by other decisions.</td></tr>
<tr><td colspan="2">SA&D class: with double the class time available, the essence of the two classes could be accommodated in one, with the underlying material covered thoroughly (as was the focus with students new to the material), and game-based learning (as was the focus with the repeating students), included. As was the situation in the past, the three focal points are central in supporting the instructional design of SA&D. With the additional time, a more fragmented approach is possible, with it being possible to place a slightly different emphasis on each contact period allocated per week. Although supplying relevant feedback in a timely fashion, was considered to be of the utmost importance with the previous parallel AR cycles, this focus is narrowed with the subsequent planned cycle. Supplying relevant feedback in a timely fashion is important, but when possible, relevant feedback should be supplied immediately.</td></tr>
<tr><td colspan="2">Context: the objective of the overall instructional design as a system is to guide each student to develop in terms of their SA&D skills and as life-long learner.</td></tr>
<tr><td> Class of repeating students: the original idea of the lecturer to support individual students, which should manifest in the encouragement of active participation, and therefore growth to an individual's full potential by making focused resources available to them, was amplified by splitting the class.
The new situation created an opportunity for redesign, while in keeping with their basic knowledge of the material. In addition to this pre-knowledge of SA&D, which was anticipated to support the scaffolding of new knowledge, the smaller group enabled a more focused approach, allowing closer interaction between the lecturer and the group.
From a critical perspective, it is important to recognize that a repeating student has, per definition, been negatively affected and is therefore in need of additional attention.
Keeping in mind that this new group of students failed the SA&D subject module during a preceding year, it was deemed important to make an effort to re-focus the learning of this group. The fact that the repeating learners did not pass the module may be due to any of a number of reasons such as financial difficulties, personal problems, low motivation, or other obstacles. The focus was not on the pass rate of the group as such, but rather a broader perspective, as promoted by Bunce and Bennett (2019:2), as well as Nixon et al. (2018:939). The purpose of the class design was to create a positive and rich learning environment.
Taking the pre-knowledge of this group into consideration, it was decided that this group should write the semester assessments, and complete a project which commences very early in the semester. Also, it was decided that the group of repeating students would not be required to write the baseline tests, and also not do the weekly assignments.
To allow the repeating students to build participation marks, new instruments had to be designed in accordance with their needs. Discussions with the students and colleagues indicated that a game-based approach may best assist learning. By design it inverted the class. </td>
<td> Class of newcomer students: initially a student as newcomer to SA&D, with no SA&D background, was the inspiration for the instructional design. The underlying nature of the SA&D subject modules themselves were also taken into consideration, where a plethora of techniques are made available, each suited to particular scenarios, and some across contexts. Keeping life-long learning in mind, students need to be able to decide when a particular tool will fit a matching situation. Awareness supported this goal.
From a critical perspective, it is important to open up the material, overwhelming in its volume, while keeping students interested. Therefore, ways to acquire information and internalise the content, are important. It was important to make students aware that each individual only need to utilise the learning tools which help them to acquire the knowledge they need. Equal emphasis is placed on study units, and the weekly class tests and assignments require newcomer students to work and learn unceasingly throughout the semester.
Similar to the group of repeating students, the focus of the newcomer group was not placed on the pass rate of SA&D, but rather to create an environment supporting all student preferences regarding the acquiring of information. </td></tr>
</table>

Table 9.5: Churchman's considerations in diagnosing the instructional design of the class of SA&D: environment

<table>
<tr><th colspan="2">Diagnosing the instructional design of SA&D</th></tr>
<tr><td colspan="2">Environment: Churchman (1968:36) posits that the environment of a system cannot be influenced by the system, but it influences the objectives of the system.</td></tr>
<tr><td colspan="2">SA&D class: a changed environment – where students have ample class time, the practical venue is sufficient to accommodate all students at the same time, and mobile devices allowing more and more access to material, makes it possible to combine the repeating and newcomer groups of students, while including the foci of the two groups in one group.</td></tr>
<tr><td colspan="2">Context: the environmental aspects of this study are:
• Poor socio-economic background.
• Limitations in practical laboratories on campus.
• Specific functionality of the LMS outside campus boundaries.
• Limited contact time: only two double contact sessions.
• Limited study hours per module in the programme.</td></tr>
<tr><td>Class of repeating students: the insufficient seating in the practical venue was solved by implementing two practical groups. Venues used for theory classes were sufficient to accommodate both groups, which resulted in a class split only for the weekly double contact session reserved for the practical class work session, although practical venues are not suited for the game-based focus of the intended instruments. Also, the intention was to use the project groups in the games planned, to create an atmosphere of competition.</td><td>Class of newcomer students: limited contact time in SA&D, a subject relying on students spending much time in analysing, designing, and developing a prototype, make students dependent on access to either their personal devices, or practical venues. Since practical venues are used by all university students, it is of the utmost importance to balance the limited contact time available between covering theoretical concepts and the practical application of concepts, with the support provided when students venture outside the classroom in developing the practical group project. This aspect of the environment is more important in the newcomer context in comparison to the repeater context, since it is their first exposure to project work in the IT course.</td></tr>
</table>

Table 9.6: Churchman's considerations in diagnosing the instructional design of the classes of SA&D: resources

<table>
<tr><th colspan="2">Diagnosing the instructional design of SA&D</th></tr>
<tr><td colspan="2">Resources: opposed to the environment, resources can be manipulated in the system and utilised to reach the objective of the system (Churchman, 1968:37).</td></tr>
<tr><td colspan="2">SA&D class: Most learning resources are retained with the following changes planned:
• Class Work was retained from the AR Cycle N, but its focus changed to include questions which may be asked in assessments. Questions are answered by students in the class, and immediate feedback is provided by a student assistant. Computerised game-based learning was adopted from AR Cycle R at the start of each session.
• A scenario, covered in a way supplemental instruction would be conducted, was introduced to allow students to think about potential practical settings which may be described and questioned in assessments. Scenario questions are considered by students, with the help of a student assistant. It is anticipated that questions would guide actions to be performed in the group projects.
• Workshop sessions were designed to incorporate the Class Work material implemented in AR Cycle N, but be more focused on project work. The intention was to indicate that which should be included in project work, to the complete part of the work in the class session, and to obtain immediate feedback from the student assistants and the lecturer.</td></tr>
<tr><td colspan="2">Context: in support of the subject plan preceding the AR cycles, shown in Chapter 3, Figure 3.2, the learning resources which were relied upon to support students in their endeavour to internalise concepts, with the motivation for the inclusion of each, can be referred in Chapter 3, Table 3.3.
The instruments contributing to the participation mark of the students – for both semesters – are shown in Table 3.4.</td></tr>
<tr><td>Class of repeating students: before the splitting of the class, the three focal points were at different stages of development. Therefore, since the splitting of the classes, the three focal points could be utilised as resources for both groups. All resources available to students before the splitting of the class, were still accessible, but the focus moved away from formal teaching and assessments, toward game playing for the purpose of earning marks. Class work, done by the newcomer group during the weekly practical double contact session, was discarded in favour of playing games. In addition to the games as instruments, contributing to the participation mark in replacement of the class tests, an assignment, called the "big assignment", replaced the weekly assignments in contributing to the participation mark.
In the design of the inverted class, it was decided to incorporate interactive activities with an underlying competitive nature. Already existing project groups were included in the design of instruments. Study units covered in the first semester of SA&D were grouped into three categories and were matched to three types of competitions (Chapter 5, Table 5.2).
A third instrument contributing to the participation mark, draws on an activity included in the second semester module, where the project groups are required to do a weekly presentation of project implementations per study unit. Since the repeating learners are starting with their project work at the start of the semester, this instrument supports the weekly progress of the project work. It has the intention to develop the presentation skills of learners and hone their critical voice.
The instruments that are contributing to the participation mark of the group of repeating students, is shown in Table 5.3. The allocations for the second semester stay as it is indicated in Table 3.4.</td><td>Class of newcomer students: the three focal points were at different stages of development before the splitting of the class. Therefore, with the splitting of classes, the three focal points could be utilised as resources for both groups.
All the resources made available to SA&D students before the class split, are still used for newcomer students after the split (Table 3.2). In the same way by which all this material is available to repeating students, although not in such a way where it contributes marks, the material used by repeating students are made available to newcomer students, again, not in such a way where it contributes marks: material prepared, and feedback on quizzes, happy hours, and expert witnesses.
The instruments which are contributing to the participation mark of the group of newcomer students, is shown in Chapter 8, Table 8.2. The allocations for the second semester stay as it was indicated in Table 3.3.</td></tr>
</table>

Table 9.7: Churchman's considerations in diagnosing the instructional design of the classes of SA&D: components

Diagnosing the instructional design of SA&D	
Components: components are subsystems in support of reaching the overall objective of the system. Each subsystem also has the characteristics of a system as listed in this table (Churchman, 1968:39).	
SA&D class: one class, incorporating teaching and learning in a positive and rich learning environment in which students are encouraged to actively participate and thereby developing their full potential. The weekly teaching of study units individually supports the management of the overarching objective. In support, the amended three focal points collaborate with the study units to ensure that the overall objectives of the subject modules are achieved.	
Context: with different strageties for dividing the systems into components possible, it was decided to combine teaching and learning – along with the study units as components – with the contextual focus on the students and the splitting of the original class into a class group of repeaters and a class group of newcomers. After dividing the SA&D class group into two main components, for repeaters and for newcomers, this refined component division is applied to the group.	
Class of repeating students: the repeating class component utilises teaching and learning to enable the overarching objective of developing a positive and rich learning environment in which repeating and newcomer students are encouraged to actively participate and thereby developing their full potential. The weekly teaching of study units individually supports the management of the overall objective. In support, the three focal points collaborate with the study units to ensure the overarching objectives of the subject modules are achieved.	*Class of newcomer students*: the newcomer class, is the second component, which is addressed in the AR cycle involving newcomer students. Teaching and learning enable the overarching objective of developing a positive and rich learning environment in which newcomer and repeating students are encouraged to actively participate and thereby developing their full potential. The weekly teaching of study units individually supports the management of the overall objective. In support, the three focal points collaborate with the study units to ensure the overarching objectives of the subject modules are achieved.

Table 9.8: Churchman's considerations in diagnosing the instructional design of the classes of SA&D: management

<table>
<tr><th colspan="2">Diagnosing the instructional design of SA&D</th></tr>
<tr><td colspan="2">Management: management is the coordination of the resources which are subject to the constraints of the environment – by means of the components – in order to achieve the stated objective (Churchman, 1968:44).</td></tr>
<tr><td colspan="2">SA&D class: combining the repeater class with that of the newcomers, required an amendment to the subject plan once more. The adjusted subject plan is shown in Figure 9.2. The changes to resources are reflected. The larger focus on immediate feedback is not reflected in the subject plan, but an important part of its successful implementation. Student Assistants are employed to support the lecturer in this endeavour. The three focal points are incorporated, with amendments as suggested. In addition to supplying meaningful feedback speedily – to motivate students and to assist them in learning from their mistakes, the allocation of bonus marks is included to ensure that activities which did not count marks toward participation in the past, are now included.</td></tr>
<tr><td colspan="2">Context: the initial intention regarding the subject modules was to teach the modules in a structured way. Resources were developed with the following outcomes in mind: the lecturer needed to familiarise herself with the subject material as taught in this particular context, before making any major adjustments to the classes, and continuous preparation of the material by students was required, to ensure that all the material may be learned thoroughly. Assumptions made by the lecturer, include:
• The NWU Sakai-based LMS, eFundi, was used as much as possible to facilitate the teaching of the subject modules.
• To motivate students to prepare for class, class tests should be written before a class is offered.
• To ensure continuous learning, each study unit had an accompanying assignment.
• To facilitate students' capability to apply learned concepts in a practical setting, a weekly class work activity was completed.
Project groups had the intention to encourage students to work on their projects weekly. To support progress, three guiding instruments were utilised for the projects.
The original subject plan which was shown in Chapter 3, Figure 3.2.</td></tr>
<tr><td>Class of repeating students: the formation of a new class group required the amendment of the subject plan to integrate newly developed resources which are subjected to restrictions in the environment. The three focal points of the SMARTguides, videos, and WhatsApp as MIMA is included in the design for the repeating students' class. Resources are used in support of the components implemented, in order to achieve the overall envisaged educational purpose. The updated subject plan is shown in Figure 5.2 in Chapter 5.
For example, the WhatsApp group is formed during the first semester, while it supports the full second semester. Assessments and their weight contribution are shown with stars.
With the focus of the group of repeating students being on playing games, the activities earning marks undertaken in a preceding year, such as class tests, assignments, and class work, became part of the resources to be utilised in preparing for the games. Also, the formal class became part of the toolbox of instruments from which to choose in preparing for the games. This purposed that each student was encouraged to direct his/her own learning towards becoming more self-directed learners. Partly this teaching and learning strategy has the purpose to remove some of the substantial pressure created by the weekly class tests and assignments.</td><td>Class of newcomer students: the inclusion of the three technology tools has required the amendment of the original subject plan, to support the implementation of the envisaged educational purposes underlying them. The updated subject plan is shown in Figure 8.3 in Chapter 8.
The focus of the group of newcomer students is on attending to a study unit scheduled for a particular week, with the intention to internalise the new material by placing it in context with what was covered previously, and anticipating how the material of a study unit links to subsequent material. A bird's eye view of the semester's work is therefore important and perpetually kept in mind.</td></tr>
</table>

The instruments which are contributing to the participation mark of the students, is shown in Table 9.9.

Table 9.9: Instruments contributing to the participation mark

Semester 1 Group: newcomer students	Number	Weight	Semester 2	Number	Weight
Weekly class test (10 tests)	10	10	Weekly electronic class test (10 tests)	10	*0
Weekly assignment (10 assignments)	10	10	Weekly assignment, two versions (10 assignments)	10	20
Semester tests	2	50	Semester test	1	40
Game-based assessment	10	Bonus 1-2-3	Game-based assessment	10	Bonus 1-2-3
Workshop	10	Bonus 1-2-3	Workshop	10	Bonus 1-2-3
Group project 1. Consultation (5) 2. Final presentation & demonstration (20)	 1 1	30	Group project 1. Weekly presentations (5) 2. Consultation (5) 3. Final presentation & demonstration (30)	 1-2 1 1	40

* It is the prerogative of the lecturer to use the marks – if it is deemed necessary

The adjusted subject plan is shown in Figure 9.2. It is an amendment to the original subject plan.

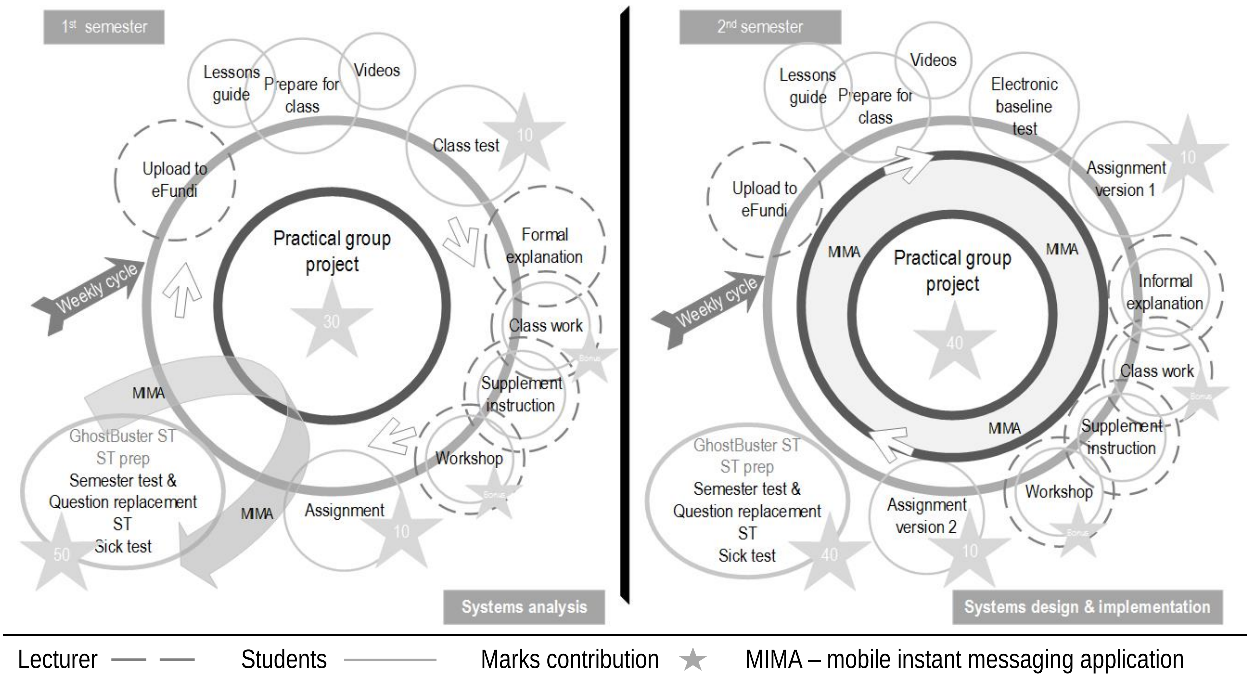


Figure 9.2: Adjusted subject plan – all SA&D students

The preceding subject plans from Chapter 3 (Figure 3.2), Chapter 5 (Figure 5.3), and Chapter 8 (Figure 8.3) is shown once more, in Figure 9.3, to allow the reader to follow the progress.

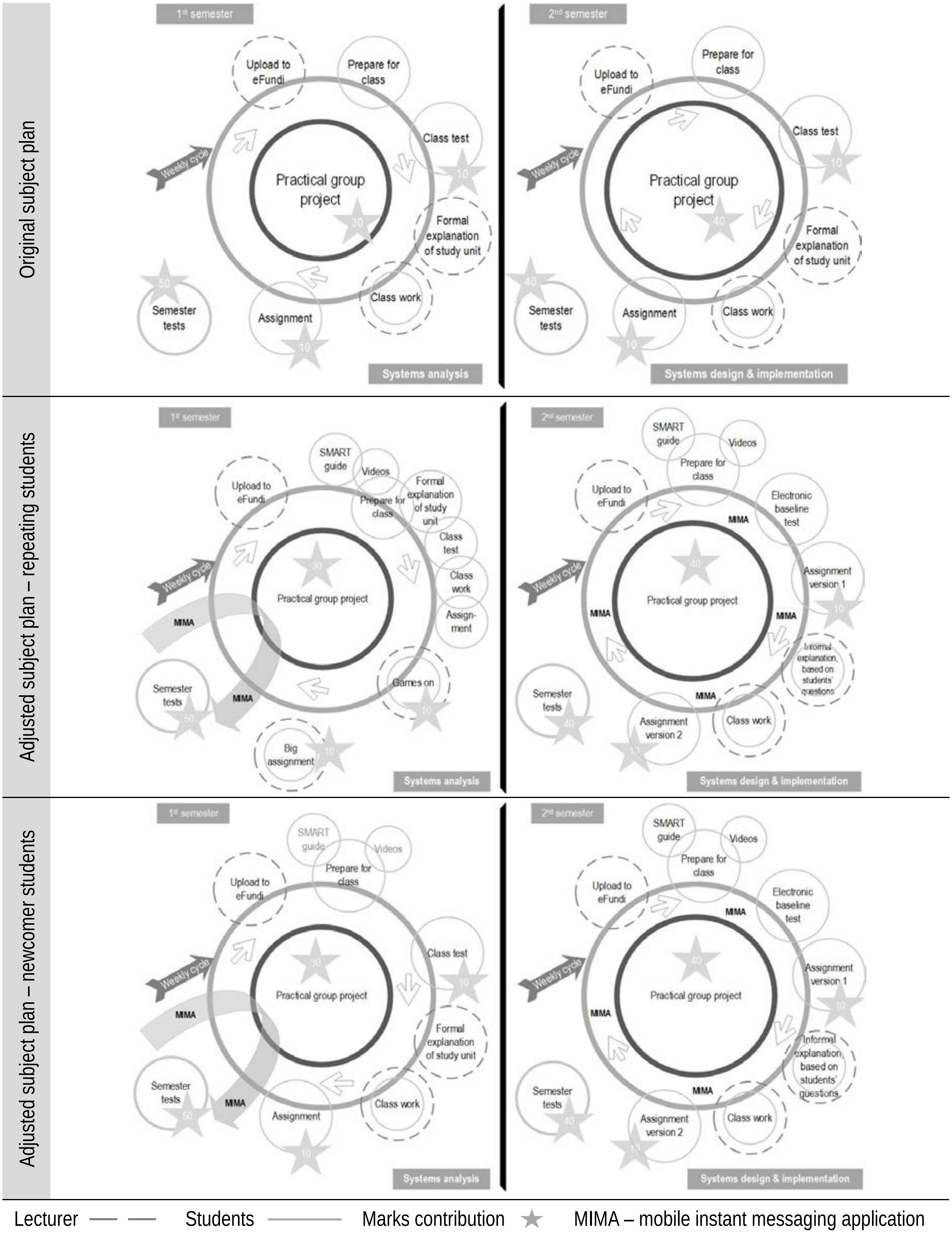


Figure 9.3: Preceding subject plans

Both semesters are shown in the revised subject plan for all students, which now singularly directs the management of the instructional design of SA&D, and all activities performed. The resources of the system are indicated with circles. Each weekly cycle starts with the necessary resources and activities being uploaded onto eFundi – part of the instructional design environment, and progresses clockwise. Circles with broken lines are showing eFundi uploads or printouts by the lecturer. Solid circles show activities done by students, either individually or in groups. The components as focal points, form part of each weekly cycle, as soon as its incorporation is possible. Assessments and the weight contribution of each is shown with stars.

9.6 AR CYCLE C – PLANNING FOR ACTION

Planned action assigns activities intended to relieve problems in the research environment. The discovery of generalised guidelines were used to amend the three focal points which support SA&D. These are presented for demonstration purposes. In addition, SA&D instruction has been newly designed. The amended class components of the two modules are shown in Table 9.10.

Table 9.10: Class component semester comparison

Component	Motivation for its use in SA&D I	Motivation for its use in SA&D II
eFundi uploads include all material students may need on a weekly basis	The weekly assignment, class work questions, as well as feedback on scenario-based questions, tests and assignments are uploaded on a weekly basis. Students are allowed to see uploaded material one week before class (upon request this may be extended by a few days) to allow students to finish the work of a previous week before they start with the new week's work. This arrangement prevents students from finishing work ahead of time and then not being able to contribute to class work, because they forgot what the work was about.	
Preparation for class	Only a scan of the chapter would be sufficient during the first semester.	More time needs to be spent on pre-class preparation during the second semester.
Class tests, acting as baseline tests.	A 5 mark paper-based test is written at the start of class. A show of hands and informal questions are used to determine the gaps in student knowledge.	A 5-mark electronic test conducted on eFundi the day before class is used to force students to be prepared; and to give the lecturer an indication of which aspects the students struggle with.
Class with formal or informal explanation	Class time is used to teach concepts in depth. This is done at the start of each week. More time is allocated to work identified as difficult.	A few informal questions are posed to students to obtain their interpretation of answers. Depending on the quality of their answers, the first part of the class may be spent building a clearer understanding of involved concepts.
Class work	Class Work was retained from the AR Cycle N, but its focus changed to include questions which may be asked in assessments. Questions are answered by students in the class, and immediate feedback is provided by a student assistant. Computerised game-based learning was adopted from AR Cycle R at the start of each session. Class work questions are prepared to allow students to get a clear idea of how questions on a particular chapter may be posed.	

Component	Motivation for its use in SA&D I	Motivation for its use in SA&D II
Assignments (versions)	Students complete assignments at the end of each week.	Students finish a first version of each assignment the night before class. Although students are encouraged to make this version the final one, they are allowed to hand in an updated version of the assignment the day after class. Each version counts half of the marks allocated. The first version counts the full marks, if no updated version is uploaded.
Scenario	A scenario, covered in a way supplemental instruction would be conducted, was introduced to allow students to think about potential practical settings which may be described and questioned in assessments. Scenario questions are considered by students, with the help of a student assistant. It is anticipated that questions would guide actions to be performed in the group projects.	
Practical workshop	Workshop sessions were designed to incorporate the Class Work material implemented in AR Cycle N, but be more focused on project work. The intention was to indicate what should be included in project work, to the complete part of the work in the class session, and to obtain immediate feedback from student assistants and the lecturer.	
Practical group project	During the fifth week of the semester, students form groups of 3-6 members and start with their practical group project. The first semester is used to prepare the system's analysis.	Students continue with their projects (in some cases they may re-group) and do the system's design and implementation.
Semester tests	Students write a semester test during the test week and two other tests. Either the semester test or the average of the two other tests count toward the participation mark.	Students write a semester test during the test week and another test. Either the semester test or the other test count toward the participation mark.

9.6.1 Demonstration: Lessons

With the SMARTguide not supported by the North-West University beyond 2019, the SMARTguides were still utilised in 2019. In addition, two complete SA&D II study units were developed in eFundi's Lessons, for the purpose of demonstration. It was decided to simulate the look and feel of the SMARTguide on eFundi Lessons, but to reflect the changes in instructional design, by dividing work in bite-sized chunks which clearly reflects what should be done in a particular week regarding the relevant study unit. For example, the outline of SA&D II study unit 1, is shown in Figure 9.5. It clearly addresses background material of a particular study unit, what is expected from a student before classes commence, what students may expect in each contact session, and lastly it allows the lecturer and the students to reminisce on a study unit.

The main advantage of using eFundi Lessons, when compared to the SMARTguides, is that Lessons may be set up in such a way that, once a student is logged on to eFundi, (s)he may be directed to the activities to be performed, either on eFundi, to write an electronic test, or access an assignment, or on another site. Here Padlet is an example of a non-eFundi application utilised for the purpose of summarising class discussions.

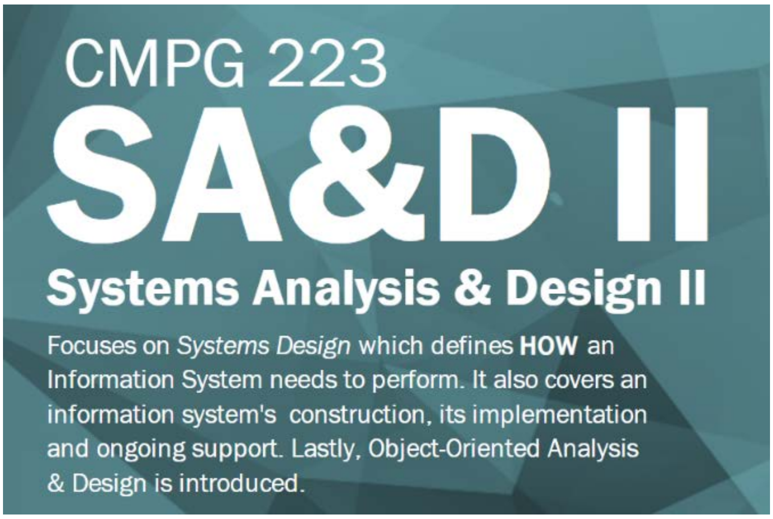
Also, the integration of an electronic study guide with eFundi assists the lecturer in the immediate allocation of marks via the eFundi Gradebook functionality. In essence Lessons enfolds eFundi, and may be used to guide the student effectively.

One concern regarding the use of Lessons, is the limited access which is anticipated when students are not on campus. During the AR Cycle N, one participant relayed the challenge of accessing the data hungry eFundi when reliant on one's own data – for those students with budget constraints.

9.6.1.1 Illustrated generalised guidelines

In this section, the eFundi Lessons developed for demonstration purposes, are used to illustrate the application of the generalised guidelines by means of examples. Speech blocks are used to link a guideline to an example when an explicit link exists. A number referenced in a speech block refers to the guideline as listed and numbered in Table 9.3. Text are listed at the right hand side or bottom of each example whenever there is an implicit link between the example and a guideline. Whenever it is deemed necessary to highlight parts of an example, such part may be blocked, and/or arrows may guide the eye.

The first example of the eFundi Lessons identification page for SA&D II, is listed in Figure 9.4. It relays the theme of the Lessons for the semester. Since the two SA&D semesters each has its own theme, it would be easy to orientate oneself.



<u>Guidelines applied here</u>

Technology

Prevent mistakes, or allow for its clear identification – 3.3(1):

- All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.
- Technology tools should be designed in a way which is aesthetically pleasing and to facilitate understanding.

Figure 9.4: SA&D II, study unit 1, Identification page

In the next example a part of the SA&D II, study unit 2 tabs, are shown to illustrate how the work required of each student are divided into small, digestible parts. At the same time tabs access more in-depth sources of knowledge. Figure 9.5 is a good example of how the eFundi Lessons technology is used to guide students to internalise content.

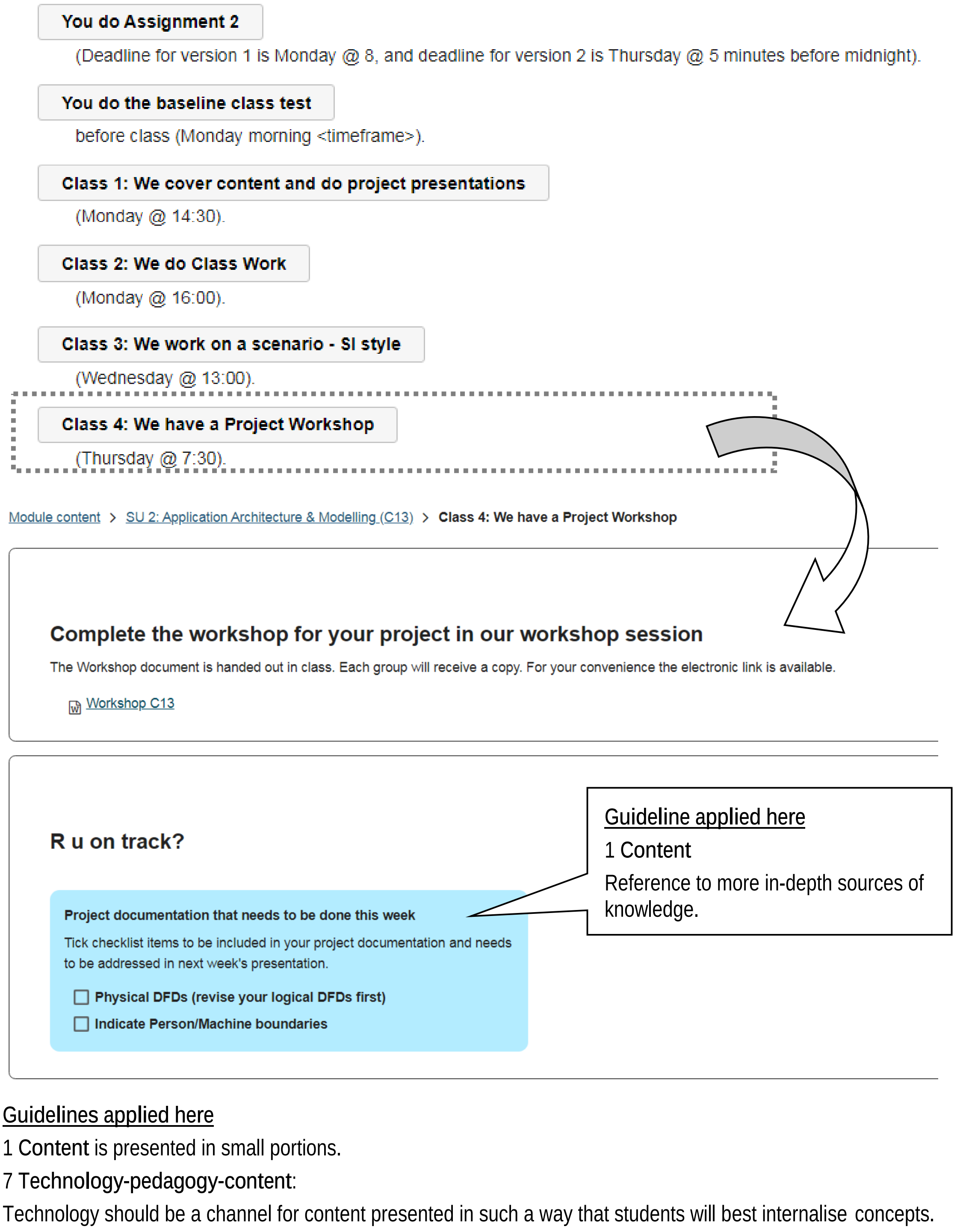
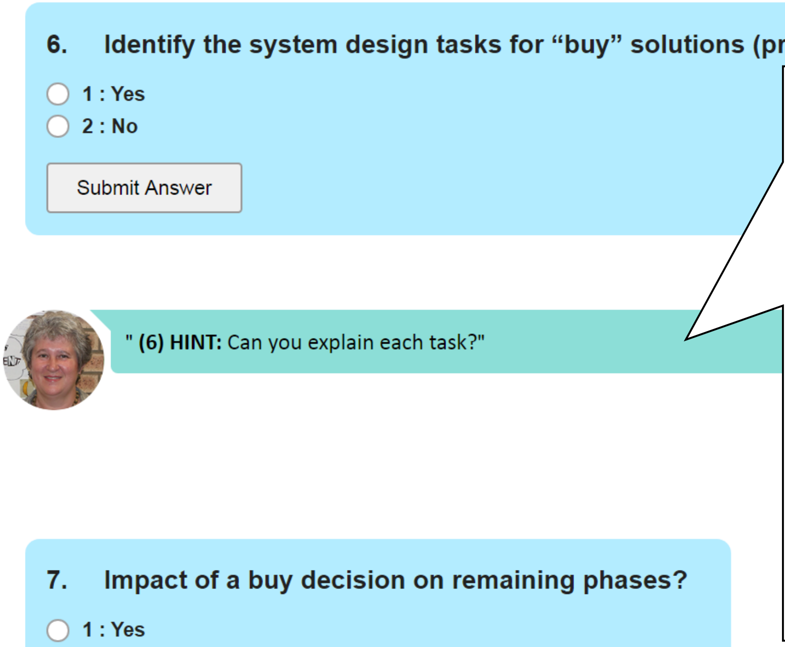


Figure 9.5: Example: the outline of SA&D II, study unit 2, with the content of one of its tabs

Figure 9.6 shows a snippet of a poll conducted when a student prepares for a study unit. It guides the student regarding the knowledge to be acquired. At the same time, the lecturer gathers information before the class commences – regarding the outcomes which need special attention. The example illustrates how small portions of in-context material may direct learning.



<u>Guidelines applied here</u>

Technology

Capabilities performed according to user intentions – 3.5(2):

- Technology tools should facilitate in-depth learning.

5 Technology-content

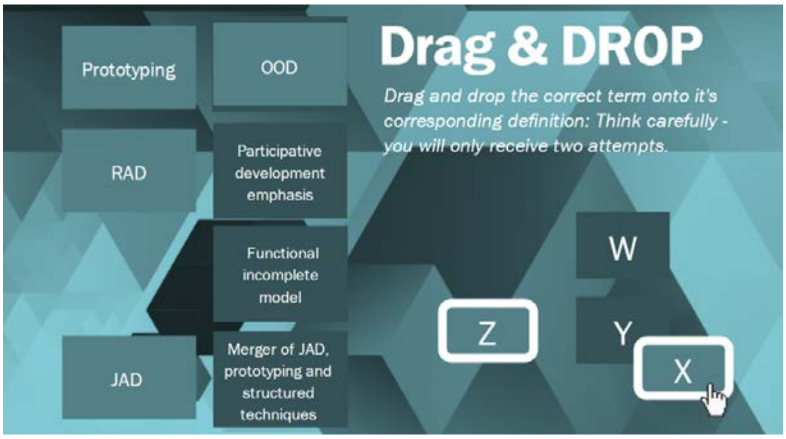
The presentation of small portions of interactive in-context material to direct learning when needed, should be the focus.

6 Technology-pedagogy

Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.

Figure 9.6: The poll listed in SA&D II, study unit 1, to guide a student in terms of required pre-knowledge

Figure 9.7 shows an example of an interactive self-assessment test included in Lessons. The colour, and animation (the “*X*” is moved to illustrate what is expected of the student) conveys the purpose of the activity.



<u>Guidelines applied here</u>

Technology

Consistency and familiarity facilitate learning – 3.1:

- Interactivity should be applied in a way which the specific tool allows.

Multimodal dialogue includes multiple human senses – 3.6(1):

- Colour (and sound), combined with a strong message which clearly conveys the purpose of a concept may facilitate understanding.

Figure 9.7: SA&D II, study unit 1, Drag-and-drop self-assessment activity

The same example is used next in Figure 9.8, showing the feedback which would be supplied after a student completed it incorrectly. The test allows for mistakes, and may be repeated. It is anticipated, that a student not providing the correct answer would make use of tools beyond Lessons, such as the textbook, or WhatsApp to identify mistakes.

Guidelines applied here

Technology

Allow for recovery from mistakes by returning to a previous state- 3.4:

The use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding.

Capabilities performed according to user intentions – 3.5(1):

- The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding.

Guidelines applied here

Technology

Multithreading supports simultaneous tasks – 3.6(1):

- Colour (and sound), combined with a strong message which clearly conveys the purpose of a concept may facilitate understanding.

Timely communication of task status – 3.7:

- Interactivity should be applied in a way which the specific tool allows.
- All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.

Guidelines applied here

Technology

Prevent mistakes, or allow for its clear identification – 3.3(2):

- Technology tools should be designed in a way which is aesthetically pleasing and to facilitate understanding.

Figure 9.8: SA&D II, study unit 1, Drag-and-drop with interactive feedback

The last Lessons example, shown in Figure 9.9, illustrates how it may be used to guide students by means of electronic constraints. In the example, submission for assignment 2, version 1 is open, and students are alerted that they need to submit this version before they will be allowed to submit version 2, which is shown as closed for submission. The asterisk next to the first version submission indicated a pre-requisite to the next step.

Not all the generalised guidelines could be applied in the context of Lessons. In Section 9.6.4, Table 9.13 is included to summarise the guidelines applicable to each of the three focal points.

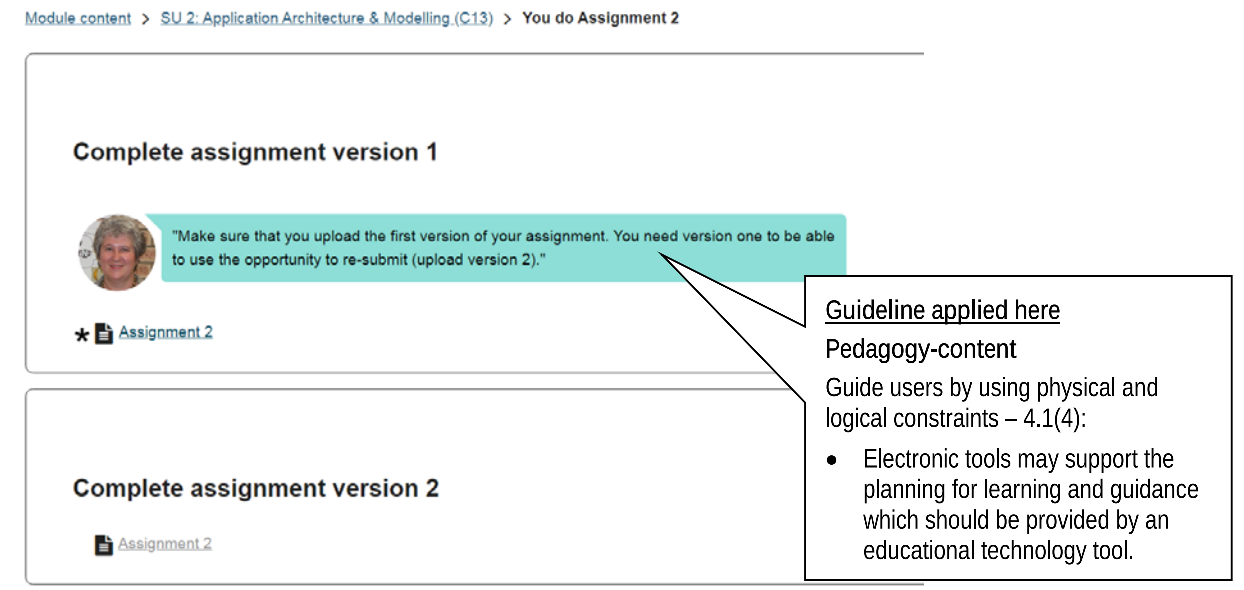


Figure 9.9: SA&D II, study unit 2, directing assignment submission

9.6.2 Demonstration: Videos

One demonstration video was made, and covered the concept of PERT charts. Although the topic already had videos explaining the concept, it was lacking in two important ways. The first was the fact that a number of participants felt that examples covered in the videos were simple scenarios which should be followed up with more complex examples. Secondly, a slight update to the methodology taught was required due to alignment of campuses.

9.6.2.1 Planning the video

Preceding the production of this video, it was decided to first determine how this video should be made, with the help of the Dooyeweerdian suite of modal aspects.

Table 9.11 reflects the 15 modal aspects, along with the lecturer's notes on how each aspect may feature in a video. Comments supplement the notes when necessary.

Table 9.11: Usage of videos to learn difficult systems analysis and design skills, categorised by Dooyeweerd fifteen modal aspects (adopted from (Basden, 2008))

Aspect	The use of video material to learn	Comments
Quantitative	The video is valid, but not too complex: • How many concepts per video? • How much time taken to present video? • Is it necessary to make a follow-up video?	When making a particular video the number of views per individual are not important. Making more than one video per concept may be important, with the subsequent video being more complex than the first. A document addressing a more complex example may be sufficient.
Spatial	Representation on the screen: • Is the space used effectively? • Is there enough white space? • Is clutter limited? • Can the students see the lecturer? • Is the size of the video manageable?	An inclusion of material of the lecturer explaining the video may be helpful in establishing the authenticity of the video in the SA&D context.
Kinematic	Direct understanding through the flow of the voice-over and writing, with rest points included: • Where is the origin of the problem? • What is the relation between the real world and the model? • How do I break down the problem? • How do I solve the problem	The flow of video material from one topic to the next is important. It may be necessary to list a breakdown with timeframes. This will allow the student viewing the video to be in control.
Physical	The model (PERT diagram) should relate to the real world: • Does the real world and the abstraction relate to one another? Also important to consider: • What is the capacity of the device used to watch the video? • What is the capacity of the network when streaming the video?	Representation of the real world in an abstract way – by drawing the PERT chart.
Organic	It is possible to link a concept with what is happening in real life: • Can the viewer identify the abstraction regarding the topic with what is happening in real life? Also important to consider: • Is watching a video an interruption which hinders study progress? • Is watching a video an interruption which sparks understanding or motivate deeper learning?	A pause in the video allows the viewer to rest (take a break), and also to act (answer the question), which enables verification (of the student's answer).

Aspect	The use of video material to learn	Comments
Sensitive	The video should convey the passion and emotion of the presenter: • Is interpretation reflected regarding how the visual material represents an answer, while the hand written sections show the underlying thinking? • Is the video including the presenter's face? • Is the video reflecting the presenter's handwriting? • Does the presenter reflect being over-whelmed by the problem? Also important to consider: • Is the visual material and sound clear? • Is the use of colour pleasing? • Do some students feel good about using videos for learning, or do others not find it useful?	This modality reciprocates the spatial by including the visual material of the lecturer presenting the material.
Logical	The presenter demonstrates the underlying analytical thinking: • How does one distinguish between bubbles and arrows in a PERT? • How does one decompose the question/problem to ensure you understand its full extent?	
Formative	The presenter demonstrates the formation of the answer: • Does this video scaffold on pre-knowledge? • What is the process to follow in one's mind to solve the problem? • Watching the video, is it shaping my understanding? • Is the video an opportunity for a viewer to watch over the shoulder of another person answering the question? • Does the video explanation allow one to follow up with deeper learning on the topic?	
Lingual	The story of a scenario evolves from reality, is then abstracted to formulate a question, which is then solved to present an abstract answer: • Is the real-world problem clearly presented? • Is the relation between the real-world problem and its abstraction clearly shown? • When the question is resolved, can the question be obtained from the answer through a verification process?	Multiple senses should be addressed by providing visual, as well as auditory material to communicate.
Social	The story of a scenario reflects the real world: • Is social interaction incorporated in the scenario? There is a relationship between the real world and its abstraction: • Is the abstraction of reality clearly shown?	The bubbles and arrows of a PERT chart also stand in relation with one another: Do we know and apply the social rules of this community?
Economic	Redrawing the PERT may result in the use of fewer bubbles and/or fewer arrows, improved clarity: • Is it necessary to redraw the PERT diagram? • Is it necessary to draw the PERT diagram using a project management instrument (in a business setting this may be a requirement)?	The purpose of a PERT diagram is to ensure the frugal use of all resources in the completion of a project.

Aspect	The use of video material to learn	Comments
Aesthetic	An informal approach and the use of a known problem may have a harmonious result: • Does the video include some drama? • Is the presenter reflected through the video's presentation? • Is the presenter building trust?	Again this modality reciprocates the spatial by requiring visual material of the lecturer presenting the material.
Juridical	A video may be referred multiple times, and therefore should be authentic: • Is the question-and-answer correctly reflected? • Are the students made aware of the video's existence? • Is the material covered in the video important to know for assessment?	
Ethical	In itself, the creation of a video is an act of generosity: • Is the attitude of the presenter positive? • Is the presenter sharing his/her thinking process? • Is the viewer made aware of additional potential questions? • Is the viewer motivated to build other stories through the use of PERT diagrams?	SA&D differs from learning other computer science material such as programming (which is self-correcting through the use of a compiler), or theoretical material such as the history of computer development (requires one to know the facts), it is NOT self-correcting (one needs to be aware of multiple applicable techniques requiring one to apply each one correctly), and it requires more than knowledge of the facts.
Pistic	The basic assumption of the presenter should be that all viewers should be able to draw a PERT chart after viewing the video: • Is the content presented in a simplified way?	A shared vision of viewers reaching their full potential through improved SA&D knowledge, skills and attitude.

A plan of action was compiled before the actual production of the video started. The outline of the plan is reflected in Table 9.12.

Table 9.12: Action plan for the production of the follow-up PERT video

Step	Activity
1	Background in terms of what should be relayed to students should be obtained.
2	Decide on a scenario and obtain information on the scenario – dad and I are making tea for mom.
3	Abstraction of the project for the purpose of drawing a PERT chart. List tasks, a task description, allocation of resource(s), a duration, and predecessors.
4	Establish ground rules for drawing up PERT charts to guide students: • A task may not be indicated more than once. • A project has one starting point and one end, this may require the introduction of a start-node, and/or an end-node. • No nodes may "hang in the air" (no predecessor or successor). This may require the introduction of an arrow without an associated task (we use a broken line). • Two nodes may not be linked by two arrows. • Nodes and arrows must be indicated.
5	Drawing the PERT chart-as-answer.
6	Re-drawing the PERT chart-as-answer.

Step	Activity
7	What additional information may be obtained from a PERT chart? : • Determine the critical path (CP) by obtaining all paths and its corresponding duration. • Know the duration of the project. • Indicate earliest starting and latest finishing times. • Obtain task slack time.
8	List follow-up questions.
9	Indicate how one can verify an answer.
10	List another more complex example – go camping!
11	Additional material with a video breakdown indicating timeframes and a more complex example included.

Production of the video was done by utilising the Zoom web application, which is intended to facilitate videoconferencing. The production of this video allowed the lecturer as producer to use more than one computer to overlay a prepared Microsoft PowerPoint slideshow with her handwritten notes. The recording included a frame of the lecturer explaining the concept. This video was completed before the commencement of the assessment week in the offering of SA&D I. Students were made aware of the availability of the video, and its focus. Follow-up questions were asked on the WhatsApp group. This discussion is reflected upon in the subsequent section addressing the WhatsApp group.

9.6.2.2 Illustrated generalised guidelines

With the Dooyeweerdian suit of modalities used to guide the conception of the follow-up PERT video, and these underlie the derived HCI foci, this section illustrates the application of the generalised guidelines by means of examples from the video developed for demonstration. A supporting document has been developed to include a video breakdown of timeframes, and follow-up questions. Both the video and the supporting document will be incorporated in future subject module offerings.

With the length of this follow-up PERT video being just under 20 minutes, a concern is whether it should have been shorter, to ensure that more students would watch it. To address this issue, Figure 9.10 shows the breakdown of timeframes to guide students who would like to re-visit parts of it. In essence short videos have the intention of breaking down content, and the breakdown is another approach to support the content guideline.

Topic	Start	End
Introduction of the problem	00:00	01:05
Abstraction of the real life problem	01:05	05:24
Break	01:57	01:57
Draw the PERT chart	05:24	07:52
Break	05:45	05:45
Re-draw the PERT chart (and include all information)	07:52	13:22
Break	08:12	08:12
Follow-up questions	13:22	15:37
Verification | Retelling the *story* | What can go wrong?	15:37	17:10
Additional projects to work on	17:10	19:12

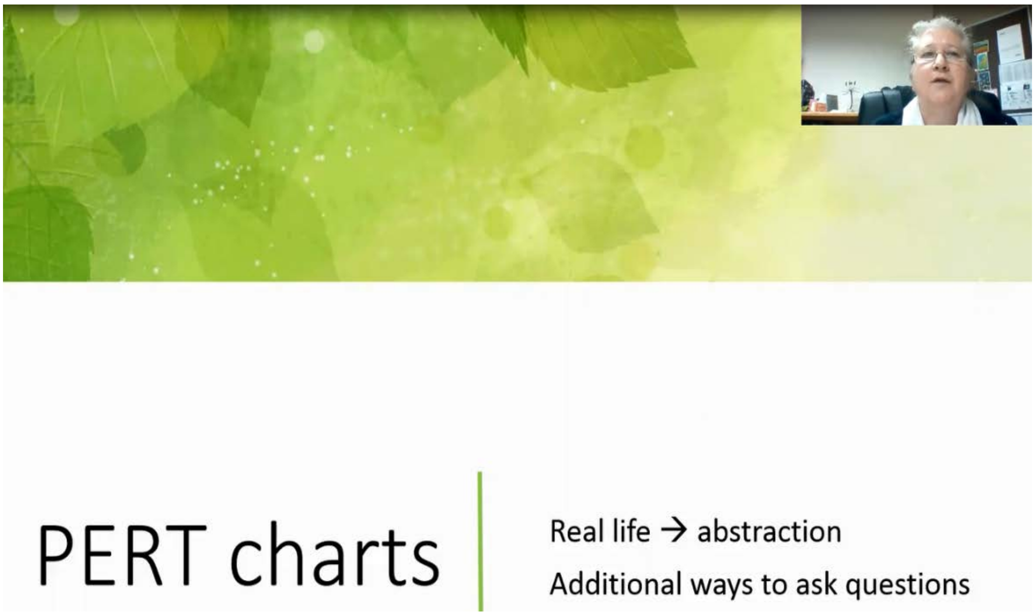
Guideline applied here

1 Content

Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge to address more complex problems.

Figure 9.10: Breakdown of timeframes for follow-up PERT video

The video was made by the lecturer, and the voice and the face of the lecturer were included throughout the video. It leaves the student with the impression that the lecturer is available beyond the class room. The latter is reflected in Figure 9.11. Videos may be accessed on most devices, and is easily accessible on mobile phones, which implies it being "*in the hand of the viewer*" – to be viewed whenever the student is in need of it.



Guidelines applied here

Technology

Flexibility allows for effective use – 3.2(2):

- The use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.

Capabilities performed according to user intentions – 3.5(1):

- The use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.

Pedagogy-content

Guide users by using physical and logical constraints – 4.1(2):

- With all types of devices considered, special attention should be given to mobile devices – to accommodate technology tools. Because of its small screens, it is imperative to compile compact chunks of information.

6 Technology-pedagogy

- Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.

Figure 9.11: Follow-up PERT video

The intention to make short videos, affords a video to cover only one topic. When a student has a need to learn about the topic, such a video may be of value. It is best to watch a video actively, and by introducing breaks – with a request to solve a problem, allows students to verify their own answers, and learn in the process. The inclusion of breaks is illustrated in Figure 9.12.

Guideline applied here

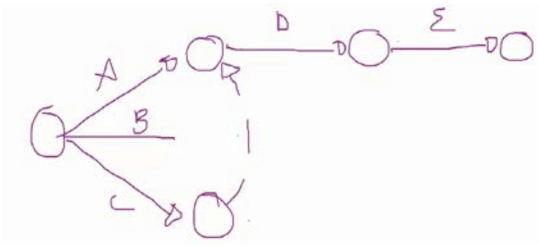
Pedagogy-content

Guide users by using physical and logical constraints – 4.1(3):

- Units of material should be compact, to present contained information designed to engage, and to allow for breaks.

Figure 9.12: Follow-up PERT video: break

A video is a powerful tool in allowing a student to "*look over the shoulder of the lecturer*", it reveals the thought processes of somebody solving the problem. In Figure 9.13, task B shows the task "*hanging in the air*" – to be resolved to obtain a final answer. It illustrates how the problem is solved chronologically, which may leave one with dead ends, which need to be resolved logically – with the thinking behind these steps shown. A step following drawing the PERT chart, an improved version of the solution is drawn (redrawing the PERT chart), to show students the most effective representation of the solution, and the thinking necessary to obtain the improved answer.



Guidelines applied here

2 Pedagogy

The identification of teaching (and learning) approaches is paramount in guiding the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.

Technology

Capabilities performed according to user intentions – 3.5(2):

- Technology tools should facilitate in-depth learning.

Figure 9.13: Follow-up PERT video: draw the PERT chart

Figure 9.14 shows an additional problem as included in the material supporting the follow-up PERT video. It addresses the issue of creating videos on challenging concepts, with only a simple example. With this additional problem, students who now understand how to draw a PERT chart should be able to complete a more complex problem, one similar in complexity to what they may expect when assessed on the topic.

Additional problem

Task	Duration (days)	Predecessor
A	1	-
B	2	-
C	1	-
D	4	A
E	5	B
F	1	C, D
G	6	A, E
H	4	F
I	2	G, H

Guideline applied here

Pedagogy-content

Guide users by using physical and logical constraints – 4.1(1):

- Examples should cover from the very simple to complex issues.

Figure 9.14: Follow-up PERT video: additional problem

Not all the generalised guidelines could be applied in the context of Videos. In Section 9.6.4, Table 9.13 is included to summarise the guidelines applicable to each of the three focal points.

9.6.3 Demonstration: WhatsApp groups

In an attempt to ensure the effective use of the WhatsApp group, a group was created one month later than was normally the case in preceding years. On the day it was created the group was closed to students, to allow the lecturer as moderator to post messages regarding the purpose of the group. On the day, the group and its purpose was addressed in class. In addition, the class representative and one other student were selected as administrators to moderate the group along with the lecturer. Also, the profile picture, similar to the one shown in Figure 9.15, was used to remind students of the rules associated with the use of the group. Only at the end of the first day, students were allowed to participate on the group.

9.6.3.1 Illustrated generalised guidelines

WhatsApp is a mobile instant messaging application (MIMA), which has been developed as a social tool, and not for the purpose of supporting the educational environment. Initially its introduction in SA&D has been frowned upon by students, but after a short period of time using it, much positive evidence is seen of its use to support the modules. Since the educator does not have control over the changes implemented to the tool, some measures may be necessary to moderate the tool. Much of these measures happen in the class and on forums other than WhatsApp. An effective way on WhatsApp itself, is to use the profile picture to remind students of the purpose of an academic group. One of the versions used in this study, is shown in Figure 9.15.

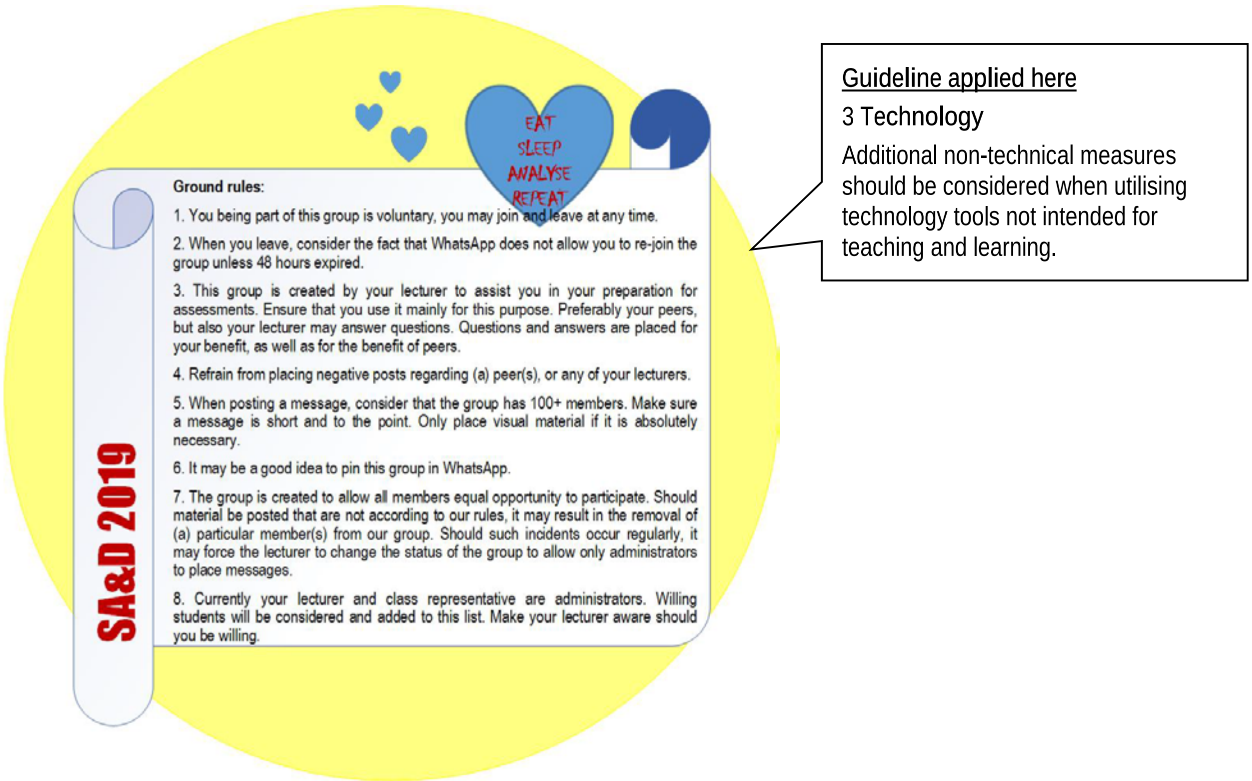


Figure 9.15: First profile picture of the SA&D I 2019 WhatsApp group

To illustrate the usefulness and effectiveness of the WhatsApp group, an example follows. The follow-up PERT video that was discussed in the preceding section, was completed at the start of the assessment week. Students were made aware of the video on the WhatsApp group, in addition to other forums (such as in class and on eFundi). A follow-up question, which was implicitly addressed in the video, was explicitly asked on the WhatsApp group. The conversation which answered this question, lasted 63 minutes (08:58 to 10:01, on 25 April 2019), with 13 students participating using 124 conversation lines. The lecturer confirmed correct answers, and asked questions when students were uncertain. Students included emoticons, pictures, and memes to express their feelings along with their answers. Only emoticons represented by the software used for the compilation of this thesis, has been retained to illustrate this. The first 30 lines of the conversation in reflected in Figure 9.16.

2019/04/25, 08:58 - [L]: Anybody who knows what the slack on A, C & D is?
2019/04/25, 09:15 - [P1]: I think it is 4
2019/04/25, 09:16 - [P2]: A, D > 2 days || Not sure if I should say C, D or just C but it's 1 day
2019/04/25, 09:16 - [P3]: I think 2 days
2019/04/25, 09:17 - [P4]: No 3 days
2019/04/25, 09:18 - [P4]: A, D 2 days || C, D 1 day
2019/04/25, 09:19 - [P5]: I think || A, D 2 days || A, C 1 day
2019/04/25, 09:20 - [L]: Between A, C, and D 3 days?
2019/04/25, 09:21 - [P6]: I'd say 1
2019/04/25, 09:22 - [P7]: 1 day
2019/04/25, 09:23 - [L]: What do you learn from the lengths of the paths? Regarding slack ...
2019/04/25, 09:24 - [L]: Start with C-D-E.
2019/04/25, 09:25 - [P8]: C-D-E is 1
2019/04/25, 09:26 - [L]: Yes, P8. CP's (B-E) duration is 15 minutes. C-D-E is 14 minutes.
2019/04/25, 09:26 - [L]: So, where will the 1 minute slack be?
2019/04/25, 09:26 - [P8]: C-D
2019/04/25, 09:26 - [P2]: C, D
2019/04/25, 09:26 - [P5]: C,D
2019/04/25, 09:26 - [L]: Which one?
2019/04/25, 09:26 - [L]: Of C and D.
2019/04/25, 09:27 - [L] added P9
2019/04/25, 09:27 - [P8]: This message was deleted
2019/04/25, 09:27 - [P9]: 😁
2019/04/25, 09:27 - [P5]: C.
2019/04/25, 09:28 - [P10]: C
2019/04/25, 09:28 - [L]: Yes, P5.
2019/04/25, 09:28 - [L]: What about D? No slack?
2019/04/25, 09:28 - [P5]: 🕺
2019/04/25, 09:28 - [P8]: Why C.?
2019/04/25, 09:28 - [P2]: There is... It is 2 minutes 🤷‍♂

<u>Guideline applied here</u>

3.4 Technology

Allow for recovery from mistakes by returning to a previous state:

- The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.

Guidelines applied here

1 Content is presented in small portions.

2 Pedagogy

The identification of teaching (and learning) approaches is paramount in guiding the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.

Technology

Consistency and familiarity facilitate learning – 3.1:

- Interactivity should be applied in a way which the specific tool allows.

Flexibility allows for effective use – 3.2(1):

- The social side should be moderated in an academic implementation. All technology tools should accommodate a diversity of cultures of its users to ensure widespread use.

Capabilities performed according to user intentions – 3.5(2):

- Technology tools should facilitate in-depth learning.

Multithreading supports simultaneous tasks – 3.6(1):

- The use of tools may energise users, while it being available acts as a backup support.

Multithreading supports simultaneous tasks – 3.6(3):

- The coordination of tools should allow the logical progression of the presentation of material according to the user's needs.

Pedagogy-content

Guide users by using physical and logical constraints – 4.1(5):

- Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.

Guide users by using physical and logical constraints – 4.1(6):

- Users should want to access an educational tool which fulfils its purpose and provide guidance, information, motivation and/or clarity according to the immediate need.

5 Technology-content

The presentation of small portions of interactive in-context material to direct learning when needed, should be the focus.

6 Technology-pedagogy

Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.

7 Technology-pedagogy-content

Technology should be a channel for content presented in such a way that students will best internalise concepts

Figure 9.16: The WhatsApp conversation following the follow-up PERT video

The full conversation is included in Annexure F: "*WHATSAPP CONVERSATION FOLLOWING THE FOLLOW-UP PERT VIDEO*". A large number of guidelines are encapsulated in this conversation, which has been relayed in the figure.

Not all the generalised guidelines could be applied in the context of WhatsApp groups. In Section 9.6.4, Table 9.13 is included to summarise the guidelines applicable to each of the three focal points.

9.6.4 Application of the generalised guidelines to the three focal points

This sub-section summarises the demonstration done in this section in terms of the generalised guidelines. In Table 9.13 the generalised guidelines are listed with the focal points applicable. Whenever a specific visual example was used, the corresponding figure is given. Whenever no specific visual example could be given a short motivation is listed. The numbering used in the preceding sections is retained.

Table 9.13: Generalised guidelines as applied to the three focal points demonstrated

<table>
<tr><th>No.</th><th>Knowledge</th><th colspan="2">Updated guideline</th><th>Focal point</th><th>Motivation</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Content</td><td colspan="2" rowspan="3">Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge to address more complex problems.</td><td>Lessons</td><td>Figure 9.5</td></tr>
<tr><td>Videos</td><td>Figure 9.10</td></tr>
<tr><td>WhatsApp</td><td>Figure 9.16</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Pedagogy</td><td colspan="2" rowspan="2">The identification of teaching (and learning) approaches is paramount in guiding the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one’s solution.</td><td>Videos</td><td>Figure 9.13</td></tr>
<tr><td>WhatsApp</td><td>Figure 9.16</td></tr>
<tr><td rowspan="3">3</td><td rowspan="9">Technology</td><td colspan="2" rowspan="3">The inclusion of technology tools requires ensuring its accessibility and therefore guidance in its use, and support regarding its download to a variety of platforms. Additional non-technical measures should be considered when utilising technology tools not intended for teaching and learning. The HCI foci listed are applicable to the technology sphere.</td><td>Lessons</td><td>By implication through the applicability of HCI foci below</td></tr>
<tr><td>Videos</td><td>By implication through the applicability of HCI foci below</td></tr>
<tr><td>WhatsApp</td><td>Figure 9.15</td></tr>
<tr><td rowspan="4">3.1</td><td>HCI focus</td><td>Enhanced guideline</td><td></td><td></td></tr>
<tr><td rowspan="3">Consistency and familiarity facilitate learning (1).</td><td rowspan="3">K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.</td><td>Lessons</td><td>Figure 9.7</td></tr>
<tr><td>Videos</td><td>Students are used to watching YouTube videos</td></tr>
<tr><td>WhatsApp</td><td>Figure 9.16</td></tr>
<tr><td>3.2(1)</td><td rowspan="2">Flexibility allows for effective use (3).</td><td>So: Of the three focal points, only the WhatsApp group supports social interaction. The social side should be moderated in an academic implementation. All technology tools should accommodate a diversity of cultures of its users to ensure widespread use.</td><td>WhatsApp</td><td>Figure 9.16</td></tr>
<tr><td>3.2(2)</td><td>Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.</td><td>Videos</td><td>Figure 9.11</td></tr>
</table>

No.	Knowledge	Updated guideline		Focal point	Motivation
3.3(1)		Prevent mistakes, or allow for its clear identification (4).	Li: In the case of all three focal points, engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.	Lessons	Figure 9.4
3.3(2)			A: Technology tools should be designed in a way which is aesthetically pleasing and to facilitate understanding.	Lessons	Figure 9.8
3.4		Allow for recovery from mistakes by returning to a previous state (5).	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.	Lessons	Figure 9.8
				WhatsApp	Figure 9.16
3.5(1)		Capabilities performed according to user intentions (6).	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.	Lessons	Figure 9.8
				Videos	Figure 9.11
3.5(2)			Pi: Technology tools should facilitate in-depth learning which should affect students in the classroom, as well as beyond the classroom in the workplace.	Lessons	Figure 9.6
				Videos	Figure 9.13
				WhatsApp	Figure 9.16
3.6(1)		Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses (7).	Ph: The use of tools may energise users, while its availability acts as a backup support. In addition, it should support the visual, and the auditory by presenting clear displays and sound.	WhatsApp	Figure 9.16 – multithreading
3.6(2)			Se: Colour and sound, combined with a strong message which clearly conveys the purpose of a concept, may facilitate understanding. An academic focus should be encouraged.	Lessons	Figure 9.7 – multithreading Figure 9.8 – multimodality
3.6(3)			Lo: The coordination of tools should allow the logical progression of the presentation of material according to the user's needs.	WhatsApp	Figure 9.16 – multithreading
3.7(1)		Timely communication of task status (8).	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement is established between components.	Lessons	Figure 9.8
3.7(2)			Li: In the case of all three focal points, engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.	Lessons	Figure 9.8
4	Pedagogy-content	Content should be taught in a way which conveys the message of the material learned. Typically, a particular technology tool would support only a part of the overall approach. In an academic context, students should be made aware of the existence of technology tools, the value		Lessons	By implication through the applicability of HCI foci below

No.	Knowledge	Updated guideline		Focal point	Motivation
		of each tool, and how to use it in conjunction with non-technical tools. The HCI foci listed are applicable to the pedagogy-content intersection.		Videos	By implication through the applicability of HCI foci below
				WhatsApp	By implication through the applicability of HCI foci below
		HCI focus	Enhanced guideline		
4.1(1)		Guide users by using physical and logical constraints (2).	Q: Only the MIMA groups have a size limitation in terms of members accommodated. In all technology tools a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number. Examples should cover from the very simple to complex issues.	Videos	Figure 9.14
4.1(2)			Sp: With all types of devices considered, special attention should be given to mobile devices – to accommodate technology tools. Because of its small screens, it is imperative to compile compact chunks of information.	Videos	Figure 9.11
4.1(3)			O: Units of material should be compact, to present contained information designed to engage, and to allow for breaks.	Videos	Figure 9.12
4.1(4)			F: The integration of electronic and other tools may support the planning for learning and guidance which should be provided by an educational technology tool.	Lessons	Figure 9.9
4.1(5)			Ec: Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore, technology tools should be compact.	WhatsApp	Figure 9.16
4.1(6)			J: Users should want to access an educational tool which fulfils its purpose and provide guidance, information, motivation and/or clarity according to the immediate need – to ensure that what is due for all is made available.	WhatsApp	Figure 9.16
5	Technology -content	Although technology typically does not constrain the transfer of large parts of material, the presentation of small portions of interactive in-context material to direct learning when needed, should be the focus when using it for teaching and learning purposes.		Lessons	Figure 9.6
				WhatsApp	Figure 9.16
6	Technology -pedagogy	Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.		Lessons	Figure 9.6
				Videos	Figure 9.11
				WhatsApp	Figure 9.16
7	Technology -pedagogy-content	In support of a lecturer, technology should be a channel for content presented in such a way through which students will best internalise concepts.		Lessons	Figure 9.5
				WhatsApp	Figure 9.16

Since it was not possible to link all focal points of this study to all of the generalised guidelines, upon reflection it was decided that the reference to “*all three focal points*” as is mentioned in generalised guidelines 3.2(1) – social modality, and 3.3(1), and 3.7(2) – lingual modality, should be removed. The ~~strikethrough~~ functionality is used to indicate which words are deleted, and *italics* to indicate changes. The updated wording is:

> So: ~~Of the three focal points, only the WhatsApp group supports social interaction.~~ *Social interaction* should be moderated in an academic implementation. All technology tools should accommodate a diversity of cultures of its users to ensure widespread use.
>
> Li: ~~In the case of all three focal points,~~ Engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.

9.7 AR CYCLE C – TAKING ACTION

In this context, the intervention has the emancipation of all students as focus. So, with the intention to emancipate them, for them to reach their full potential, the three focal points were amended according to the findings obtained in the two preceding AR Cycles R & N. The aim of this AR cycle was to use the three focal points developed as demonstration tools to evaluate whether the interpretation of the findings, is of value. With the Lessons guide included, the implementation also amends the instructional design of SA&D.

As a point of departure, the first semester classes were amended to accommodate all students, and to add additional resources. The SMARTguide was supported at the time, and therefore used. The amended approach to the MIMA groups were utilised, and the follow-up video was implemented. During the second semester, the researcher was not the responsible lecturer of SA&D, and in addition to the developed SMARTguide, two study units were also developed on Lessons.

Nine students participated in the formal demonstration and evaluation session. These participants were added to the eFundi site, with the demonstrations loaded, beforehand to allow them to view the developed material in the context of the first semester’s classes. The gathering of the biographical data was done beforehand via WhatsApp to allow the focus of the actual session to fall on the three focal points. The nine participants attended the demonstration and evaluation in two sessions, to accommodate the availability of individuals, with the first session accommodating six and the second three participants. The three focal points were demonstrated, questions were answered, and the participants completed the written interview anonymously.

9.8 AR CYCLE C – EVALUATION

This AR cycle intervention entailed placing the focus on all SA&D students, and is supported by the three focal points of this research. This demonstration was addressed in two parts, namely (1) problem solving, where the support of students to enable them to reach their full potential, and (2) research, where generalised guidelines were applied to the three focal points. Evaluation occurred by means of written interviews, a data collection strategy, and the analysis of the collected data.

9.8.1 Data analysis strategy

Chapter 2 is referred, to guide the data analysis strategy to be followed in addressing the reflective objective of this chapter. Figure 2.9, in Chapter 2, which shows the content analysis process adapted from Elo and Kyngäs (2008:110), is shown here once again. In Figure 9.17 the directed approach of content analysis followed here, is highlighted in grey.

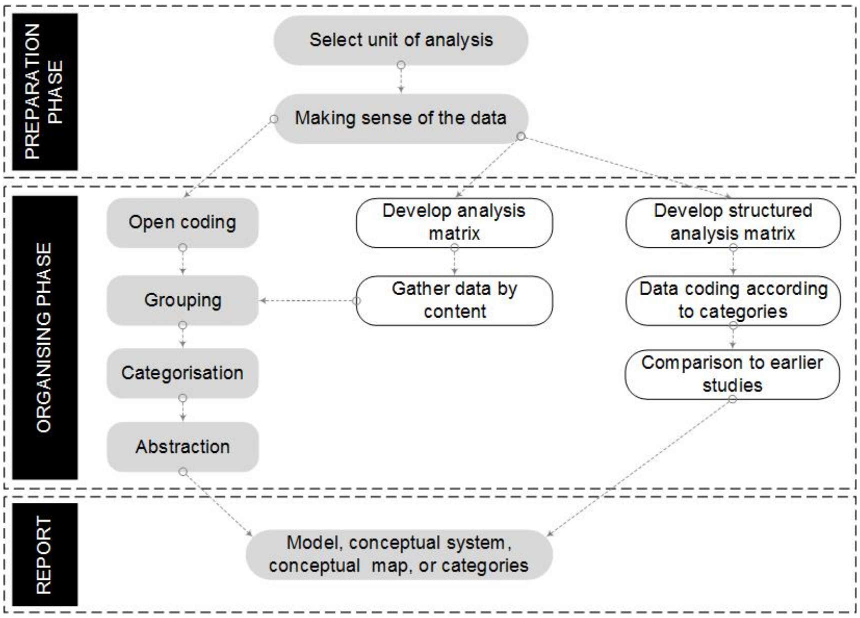


Figure 9.17: The content analysis process as adapted from Elo and Kyngäs (2008:110)

The directed content analysis approach shown in Figure 9.17 directs data analysis as follows:

- To select the unit of analysis is the first step in preparing the data. In the case of this study, the unit of analysis is an entire, written interview with each participant. By considering an interview with a specific participant as unit of analysis, the researcher could obtain an understanding wider than the specific.
- Make sense of the data and the whole, concludes the preparation of the data. Asking questions regarding *who* (spoke), *where* (did it happen), *when* (did it occur), *what* (happened), and *why* (it happened) while listening to each written interview several times, will assist the researcher in becoming fully immersed in the data.
- The organisation of the qualitative data is started with open coding. The interview questions are developed from the premise that the three focal points were improved.
- Data gathering entails compiling codes while reading each interview with the intention to describe all aspects of the interview. It often requires reading an interview more than once. Codes are presented in table format.
- The organisation of the qualitative data is continued by grouping the data. Related codes which belong together to describe a phenomenon. are grouped to form categories. Categories are used to describe focal point direction. This may include describing the success of one of the focal points, or how to improve the focal point. At the same time, abstraction is applied to the data to form themes which convey meaning with regard to regarding the research. A theme is used to describe success or a recommendation for improvement. This step concludes the organisation of the data.
- Report on the improvements suggested.

Trustworthiness is in essence not a step, but a mindfulness, and is therefore reflected upon after completion of data analysis. Since ensuring trustworthiness is involved, a list of questions have been formulated to guide it (Table 9.14).

Table 9.14: List of questions designed to guide content analysis towards trustworthiness from Elo and Kyngäs (2008:110)

No.	Question to guide trustworthiness	Motivation	Result
1	Is the process of analysis as well as the ensuing results described in enough detail?	It should be clear to readers how the analysis was done. Its restrictions and strengths should be highlighted.	A dissected process and rigorous results.

No.	Question to guide trustworthiness	Motivation	Result
2	Are the themes described by its categories, and categories by its codes?	Groupings should be anchored empirically, as well as conceptually.	Simplified data that is analysed and grouped to reliably reflect the subject under scrutiny.
3	Does the groupings cover the data well?	The researcher should be able to defend illations on sound and authentic collected data.	Detailed reporting that describes the analysis process, as well as the results. The inclusion of tables and appendixes may highlight links between the raw data and ensuing results.
4	Is the context, the participants, data collection, and analysis process described thoroughly?	Readers should be able to trace the process of inquiry followed.	Transferable research.
5	Are citations from the empirical data included without pointing to participants' identity?	Readers should be able to determine the origination of groupings.	Increased trustworthiness.
6	Was content validation done? A number of content validation techniques are available, including face validity, and the use of agreement coefficients. Options for seeking agreement may utilise a panel of experts, or dialogue among co-researchers.	Agreement on the grouping and labelling of data.	Valid coding and grouping of content.

As overarching principle, the Hermeneutic Circle with its double hermeneutic reporting, is employed as mode of analysis of this study. Three effects are anticipated: (1) the gathering of data is assumed to be affected by any presuppositions the researcher may have, and the questions asked will determine the answers of participants; (2) when analysing the data, the data is affected, and vice versa, data also affects its analysis; and (3) the context of a particular interview needs to be considered when meaning is attached to words used in the data.

9.8.2 Interview development

It was planned that, at the start of each demonstration, the ethical approach of study would be explained and the "*AUTHORITY FOR SA&D DEMONSTRATION & EVALUATION*" (Annexure G) signed. The compilation of this document was guided by the TRREE ethics course: "*ETHICAL CLEARANCE*" (Annexure A).

The biographical data was gathered beforehand via WhatsApp. These basic questions are listed in Table 9.15. Participants were also added to the eFundi site, where the demonstration material were listed beforehand.

Table 9.15: List of initial questions designed to gather biographical and background information from participants

No.	Question	Motivation
1	What is your current age?	Age may allow comparisons between interview groups.
2	Why did you decide to study IT?	Determine whether participant had a clear motivation for his/her IT studies.
3	What is your long term plan regarding your career?	Determine whether the participant has a clear vision for his/her future career in IT.
4	How many years were you enrolled for SA&DI? Have you passed SA&DI?	Determine whether the participant is new to SA&D, or repeating it.

All the questions in Table 9.16 have the aim to extract improved ways to address issues in SA&D, and the focal points with the ultimate purpose to determine its success.

Table 9.16: List of questions designed to evaluate AR cycle C and the amended focal points

No.		Question applicable to Lessons, Videos, and WhatsApp groups	Format of answer
1	a	Would you say that Lessons will work well in the SA&D context?	Multiple choice: Yes or No
	b	If your answer is yes, what is your motivation? If your answer is no, what is your motivation?	Open
	c	How can the Lessons be improved in the SA&D context? Be specific.	Open
2	a	Would you say that the PERT video worked well in the SA&D context?	Multiple choice: Yes or No
	b	If your answer is yes, what is your motivation? If your answer is no, what is your motivation?	Open
	c	How can the videos be improved in the SA&D context? Be specific.	Open
3	a	Would you say that the WhatsApp group(s) worked well in the SA&D context?	Multiple choice: Yes or No
	b	If your answer is yes, what is your motivation? If your answer is no, what is your motivation?	Open
	c	How can the use of mobile instant messaging applications (such as WhatsApp) be improved in the SA&D context? Be specific.	Open
4		According to you, is there anything that we may improve in SA&D?	Open
5		Do you have ideas regarding the inclusion of (additional) technology tools that may support student learning in SA&D?	Open

9.8.3 Data collection

With the questions finalised and the content analysis approach outlined, participants were approached for the demonstration and evaluation. For the purpose of validation, the class were asked on the still existing SA&D 2019 WhatsApp group for volunteers to attend a demonstration and evaluation session. Only one student responded, and agreed to the session. Seven more students were contacted individually by the researcher, on

WhatsApp as well. They were selected because of their perceived ability to articulate their evaluation of the demonstration, but also to include both students doing the subject for the first time, and those repeating it. Six of these students responded, and agreed to the session. Eventually two additional students joined the first demonstration session with no intervention from the researcher. With this addition, participants tallied nine.

As planned, the demonstration and evaluation had four parts:

1. The initial questions listed in Table 9.15 were asked before the actual demonstration and evaluation session, to gather biographical and background information from participants.
2. Each session was started by welcoming the participant, and emphasising the anonymity of the person. An accompanying "*AUTHORITY FOR SA&D DEMONSTRATION & EVALUATION*" (Annexure G) was signed as session register.
3. A demonstration explained the focus of the research, and showed the amended three focal points followed. All participants were added to the eFundi site which contained the demonstration, to allow them the view the material beforehand.
4. The last part of the demonstration addressed the written interview. The questions listed in Table 9.16 guided the interviews. The written interviews are captured in "*ACTION RESEARCH CYCLE C – CODE LISTS WITH APPLICABLE RESPONSES*" (Annexure H).

9.8.4 Participant detail

Table 9.17 lists the nine participants, named P1… P9. The table includes the biographical and background information obtained via WhatsApp conversations. The year(s) of enrolment (heading "*Enrolled*" in the "*Participant" column)* distinguish(es) between participants as students who were new to SA&D (2019), and those who repeated the module (2018, 2019).

Table 9.17: List of answers to initial questions designed to gather biographical and background information from participants

Participant	Clear motivation for IT study	Long term vision for IT	Current job
Participant: P1 Age: 27 Gender: M Enrolled: 2019	I was inspired by a science fiction show; I wanted to create games and have some sort of role in the digital world.	The long-term plan is to be a System Developer, using IT to solve everyday problems that people are likely to face.	No

Participant	Clear motivation for IT study	Long term vision for IT	Current job
Participant: P2 Age: 21 Gender: M Enrolled: 2019	I have a passion for technology, ever since I was a little boy.	Working for a big company and climbing that ladder.	Yes, working as a waiter on weekends.
Participant: P3 Age: 21 Gender: M Enrolled: 2018, 2019	I like solving problems, and I am always up for challenges since IT changes every time.	I want to be a senior developer.	No
Participant: P4 Age: 23 Gender: M Enrolled: 2018, 2019	I did not get into my first choice.	I am still looking into different career paths I might find most suited to me.	Yes, white board assistant for UniPrep (university preparatory course) and UODL (Unit for Open Distance Learning) at NWU.
Participant: P5 Age: 21 Gender: M Enrolled: 2019	I like a challenge and felt as if the constant push for development and improvement in the field is what I would love and so far I'm loving it.	I would like to work for 5 years (as Data Analyst or Database Administration or IT Specialist Program Developer) and then start building my own company and specialize in disability software development.	No
Participant: P6 Age: 19 Gender: M Enrolled: 2019	The world is converging into digitally-run society.	I'm working towards being a specialist in system development.	No
Participant: P7 Age: 22 Gender: F Enrolled: 2019	IT was my second option. I had wanted to study something in the medical field, due to financial difficulties I had thought why not try IT instead; that it would guarantee a job sooner rather than later.	I was planning to do my honours while in the graduates program for MBSA; move to the East London branch to learn more about their engineering & IT departments. I wanted to save enough money to study micro-robotics and if all goes well start my own tech & robotics company.	I work during school holidays – in the IT department for Mercedes-Benz SA.
Participant: P8 Age: 21 Gender: F Enrolled: 2019	I have an interest in technology. Coming up with ideas that will change the technological world, for the better.	Work in this field. Play around with code until something different happens that will improve the technological world. Help create easier programs for mankind.	No
Participant: P9 Age: 27 Gender: M Enrolled: 2018, 2019	It is a progressive field that is constantly evolving.	Owning a technology company.	No

The participant detail forms the background for the presentation and analysis of the data.

9.8.5 Data presentation and analysis

In an attempt to address trustworthiness (point 4 in Table 9.14), the steps identified in Section 5.7.1 in terms of the data analysis strategy, is followed here.

The ***unit of analysis*** as first step in preparing the data, has been established to be an entire written interview with a particular participant. By considering the entire interview as unit of analysis, the researcher could gain an understanding wider than the specific. The interview questions were developed (§9.8.2), data was collected (§9.8.3) and participant information related (§9.8.4). Answers to open questions related directly to a question.

Making sense of the data and the whole, involved reading each written interview recording several times while asking questions (*who* (spoke), *where* (did it happen), *when* (did it occur), *what* (happened), and *why* (it happened)). This enabled the researcher to become fully immersed in the data.

Data is gathered by content. Codes were compiled while reading each interview with the intention to describe all aspects of the interview.

Seaman (1999:567) coined the Glaser and Strauss's constant comparison method "*cross-case analysis*", where field notes from "*cases*" or settings are grouped. In this AR cycle, the codes extracted from a particular written interview is treated as a "*case*", allowing eight groups of data to be compared in pairs.

9.8.5.1 Presentation of the codes

Codes were formulated for the answers to the questions listed in Table 9.16 are represented in Table 9.18. Written interviews were completed anonymously, and therefore only a tally is indicated per code. When a response of a subsequent participant was added that was not indicated as a response of a participant yet, the content was revisited. Therefore, in all cases, a written interview was read more than once. When a response addressed more than one issue, more than one code were compiled to represent it.

Table 9.18: List of codes applied to the written interviews done with participants

Question with codes	Code tally
Q1 (a & c): Would you say that Lessons will work well in the SA&D context? If "yes", motivate your answer.	
Lessons are well organised	1

Question with codes	Code tally
Lessons incorporates useful features	1
A logical step by step approach	1
Lessons are more interactive than the SMARTguide	2
It is a fresh approach to a module I like	1
Lessons clarify complex concepts	1
Students see exactly what to focus on per chapter	1
A student may get immediate feedback on issues	2
Q1 (d): How can the Lessons be improved in the SA&D context?	
Include past examples to guide what needs to be done	1
Guide the fun drag-and-drop test	1
Lessons are a major improvement on what we had	1
Video tutorials on modelling are important	1
Place the emphasis on fun and learning through practice, before class	1
Scenarios must have a print option, to allow students to write down questions	1
All classes should be with the lecturer	1
Let the GhostBuster semester test count marks	1
Q2 (a & b): Would you say that the PERT video worked well in the SA&D context? If “yes”, motivate your answer.	
A video may be watched over and over, in one's own time	4
The break allows one to complete the answer and check it	1
The video facilitated my understanding	2
Q 2 (a & c): Would you say that the PERT video worked well in the SA&D context? If “no”, motivate your answer.	
A real-life example of a PERT chart will have more value	1
Q2 (d): How can the videos be improved in the SA&D context?	
Work through more examples	1
Examples on different levels of difficulty	2
Possible example: plan the construction of Curro <a school being built close to NWU>	1
The video breakdown helps	1
Videos should be short	1
Group videos in one directory	1
Lecturers from all campuses should make videos on the same concept	1
Ask students questions to determine whether they watched the video	1
Q3 (a & b): Would you say that the WhatsApp group(s) worked well in the SA&D context?	
Easy to ask questions, get quick responses	1
Get help at any moment, from the lecturer, or peers	1
Easily interact with the lecturer, and peers	2

Question with codes	Code tally
Examples of how questions may be asked	1
It helps students to figure out concepts	1
WhatsApp helped us to learn by listening to peers	1
WhatsApp helps us to see how others will answer a question	1
I learned through the questions of peers	1
Q3 (d): How can the use of mobile instant messaging applications (such as WhatsApp) be improved in the SA&D context? Be specific.	
More guidance on project work	1
Use WhatsApp to guide what needs to be completed in class	1
Get as many students to participate actively	1
Use WhatsApp to guide that which support what happens in class	1
Use WhatsApp to explain difficult concepts	1
A new rule: big files should not be posted if not necessary	1
Post one-question-a-day to be expected in assessments	1
Students should provide answers even if it is wrong	1
Q4: According to you, is there anything that we may improve in SA&D?	
Break down the work for assessments	1
We need to write more semester tests	1
Take students on excursions to IT companies	1
More elaborate videos on slides, with notes by the lecturer	1
A breakdown on how papers are marked	1
Supply an example of the documentation	1
The GhostBuster semester test should contribute	1
We need a session to work on our projects	1
Quizzes make classes fun	1
Slides should focus on practical work rather than theory	1
Q5: Do you have ideas regarding the inclusion of (additional) technology tools that may support student learning in SA&D?	
Compile a list of websites to support each study unit	1
Quizzes help us learn terminology and definitions	1
Make future students aware of Discord	1
More videos may help us catch what we miss in class	1
Make future students aware of Google Docs	1
The technology used should be utilised better by students	1
TOTAL	68

9.8.5.2 Analysis of the codes

Grouping of the data, and applying abstraction had the intention to form themes from categories which extend meaning regarding the progress of the research. The abstraction grouped all codes to form categories and themes. Five themes with its associated categories and the codes associated per category, is presented as two network diagrams in Figure 9.18 and Figure 9.19, and discussed under the subsequent headings. Related codes which belong together to describe a phenomenon, were grouped to form categories. The construction of the description was adjusted to fit in with other descriptions identifying a category.

All participants regarded eFundi Lessons (question 1 (a & b)), as an electronic guide that works well (Figure 9.18). One participant appreciated the fresh approach to the subject. Others indicated that it is organised, incorporates useful features, works through material step by step, makes complex concepts clear, and highlights the focus of a chapter. Two participants referred to the interactivity of Lessons being more than that of the SMARTguide, and two participants appreciated the immediate feedback built into it.

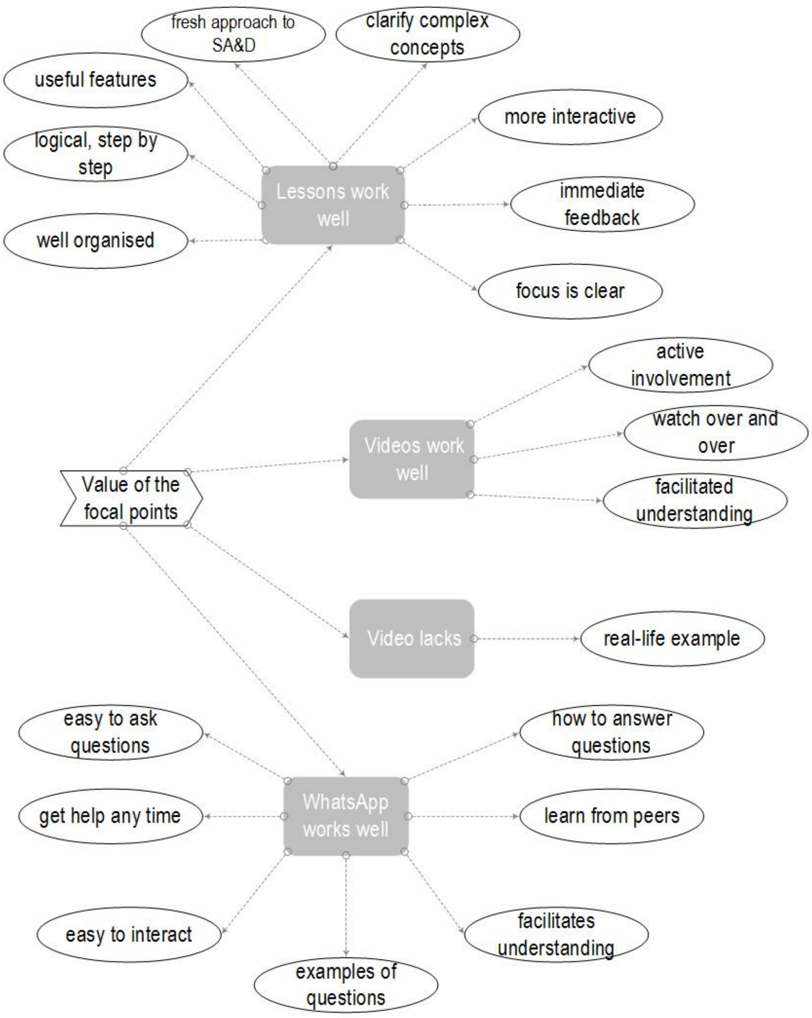


Figure 9.18: Network diagram showing theme "Value of the focal points", with its categories, each with grouped codes

All but one participant indicated that the follow-up video worked well (question 2 (a & b)), four participants valued the fact that a video may be watched over and over – in one's own time, two participants mentioned that the video facilitated their understanding. One participant acknowledged the value of including breaks in a video to encourage students to actively participate. One participant indicated that the video did not work well (question 2 (a & c)), by pointing out that a real-life example should be addressed.

All participants indicated the value of WhatsApp (question 3 (a & b)). They indicated that it is easy to ask questions on a WhatsApp group, and responses are quick, one may be helped at any time, one sees examples of questions to be asked, and learn through the answers of peers. One is supported when figuring out concepts, by listening to peers, and looking at the questions they ask. Two participants highlighted the fact that WhatsApp makes it easy to interact with the lecturer.

In the area of improvements suggested (Figure 9.19), one participant indicated that Lessons (question 1 (d)) are a major improvement on what they had in the form of the SMARTguide. It was felt that the emphasis needs to be on fun and learning through practice, with a need to guide the drag-and-drop test included. One participant expressed the need to have a printable option for the scenarios – to enable students to make notes on it. A need was identified for examples from previous years to guide actions required. Regarding the Videos (question 2 (d)) a need was expressed to have more examples available – on different levels of difficulty, especially real-life examples. Videos should be short, but otherwise the breakdown of timeframes helps. One participant suggested a directory for videos. A suggestion to get lecturers from all campuses to make videos on the same concept, and then group videos in one directory may open options for students. One participant indicated that students should indicate whether they watched the videos. Concerning the WhatsApp groups (question 3 (d)), participants expressed a need to receive guidance on project work, what needs to be completed in class, explain difficult concepts and to post one-question-a-day to be expected in assessments. It was deemed important to get as many students as possible to participate actively, and to encourage students to participate even when their answers may be wrong. A request for a new rule: big files should not be posted if not absolutely necessary.

In general (question 5), Discord, and Google Docs, was mentioned as technology tools which may support communication among students once more. In addition to the reading list, one participant expressed a need to have access to a list of websites that may support each study unit. Quizzes were mentioned as a good tool to learn terminology and definitions. One participant indicated that students should utilise the available tools more effectively.

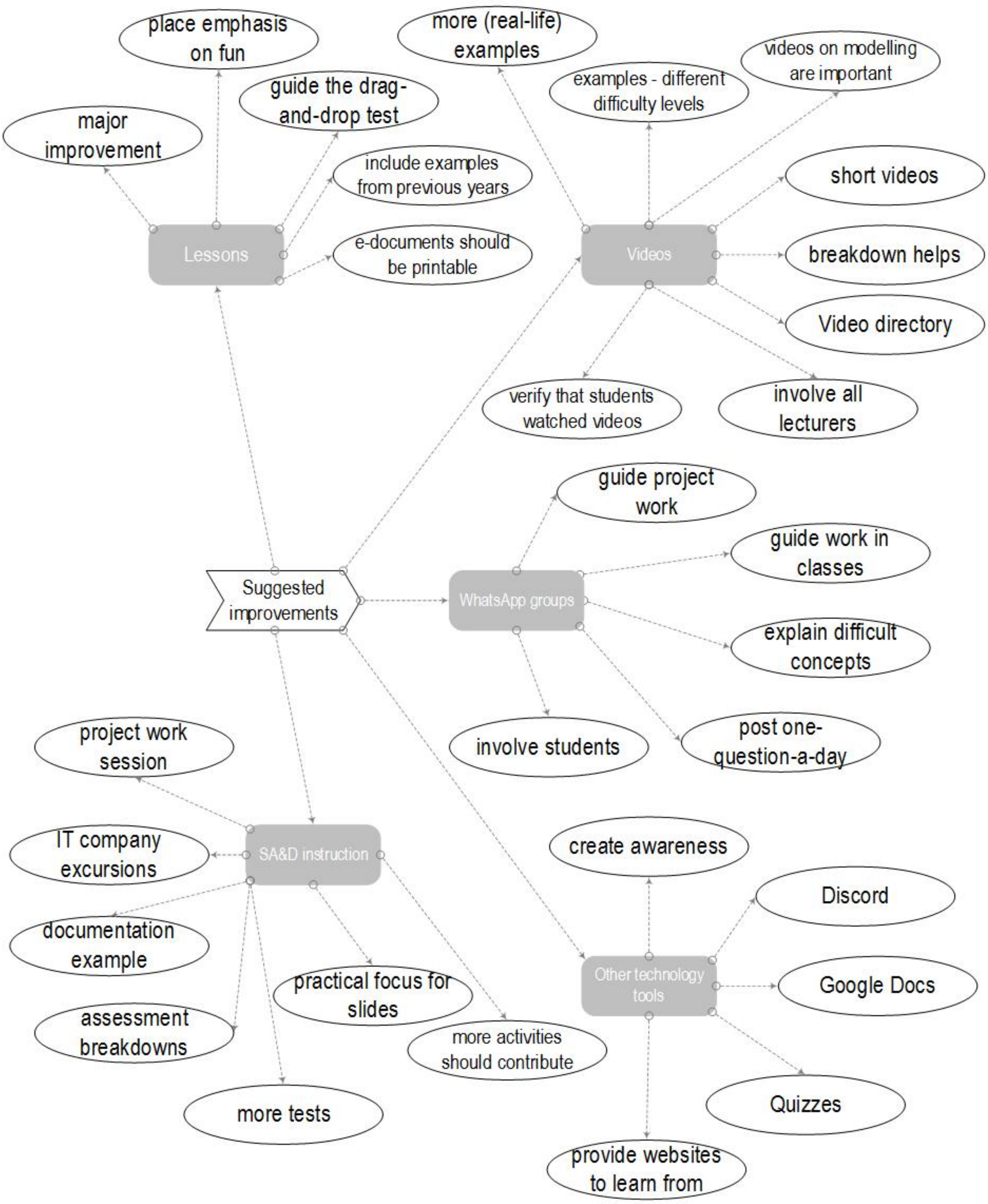


Figure 9.19: Network diagram showing theme "Improvements", with its categories, each with grouped codes

When it comes to SA&D instruction (question 4), one participant expressed the need to go on excursions to IT companies, another that all classes should be with the lecturer. Slides should focus on practical work rather than theory. An example of the documentation is an expressed need. Two participants indicated that the GhostBuster semester test, a mock test written before the test week, should contribute towards participation to motivate students to participate. Regarding assessments, a need for a work break down was expressed, along with more semester test opportunities, and then a detailed breakdown on how papers are marked. A need to have a formal session to work on projects, was also expressed.

9.8.5.3 The findings following from the analysis

The success of the demonstration intervention in terms of the "*Value of the focal points*" has been established with all responses, but one indicating that the three focal points will work well in SA&D.

Improvements were suggested, and will be considered in future implementations according to four categories:

- Lessons: build on its strengths of being organised, its focus on interactivity, and providing immediate feedback. Provision for printing of embedded documents should be made, inclusion of fun activities and examples should be expanded
- Videos: with its inherent value, well-made videos add much value to a large part of the current student population. Videos should be short, but longer videos may be supported by making a timeframe breakdown. A variety of videos made by more than one lecturer may be of value, and should provide many real-life examples – on different levels of difficulty. This may require a directory for the videos. The value of breaks is acknowledged.
- MIMAs: WhatsApp is deemed a valuable resource in SA&D. A need exists to provide support for more than assessments, such as guidance on project work, information on what needs to be completed in class, the explanation of difficult concepts, and provision for one-question-a-day. More effort should be made to involve as many students as possible to participate actively. Students may be made aware of other MIMAs such as Discord and Google Docs to support the smaller groups.
- Other technology tools: the utilisation of websites may support each study unit, and quizzes to learn terminology and definitions.

- SA&D instruction: exposure to IT companies may be a requirement linked to the practical project, more attention to contributions to participation marks may motivate students to participate in important activities.

9.9 AR CYCLE N – LEARNING SPECIFIED

At the start of this chapter, it was indicated that learning specified will focus on solving a real-world problem (P) of demonstrating the improvements applied to the subject modules of SA&D, and the three focal points to a combined class of all students. The three focal points of this study, includes instructional design using eFundi Lessons, formative guidance in the form of a follow-up PERT video, and summative assessment using WhatsApp groups. All of the changes had the purpose to emancipate SA&D students – to enable them to reach their full potential (M_{PS}). Feedback from participants validated the demonstration to determine potential to emancipate students to reach their full potential during future SA&D offerings. The focus was on the areas of "*Value of the focal points*", and "*Improvements*" regarding the three focal points, tools in general, and SA&D. The AR method was applied to the problem. The primary goal of this chapter, namely to validate the improvement SA&D with its three focal points through a demonstration and evaluation was achieved through the successful application of an AR cycle.

Establish trustworthiness. The list of questions formulated above (Table 9.14), has been utilised to verify its implementation as seen in Table 9.19.

Table 9.19: Trustworthiness verification list used to guide content analysis

No.	Question to guide trustworthiness	Motivation with references
1	Is the process of analysis as well as the ensuing results described in enough detail?	Dissected analysis was described in §9.8.5, and strengths/restrictions highlighted to motivate results.
2	Are the themes described by its categories, and categories by its codes?	Descriptions of themes, categories, and codes were done in §9.8.5.2 (illustrated by Figure 9.18 and Figure 9.19, and Table 9.18).
3	Do the groupings cover the data well?	Description of groupings was done in §9.8.5.2 (illustrated by Figure 9.18 and Figure 9.19).
4	Are the context, the participants, data collection, and analysis process described thoroughly?	Descriptions of the context are found in §9.4, §9.5 and §9.6, participants in §9.8.4 (illustrated by Table 9.17), data collection in §9.8.3 and the analysis process in §9.8.1.
5	Are citations from the empirical data included without pointing to participants' identity?	Written interviews were done anonymously.

No.	Question to guide trustworthiness	Motivation with references
6	Was content validation done? A number of content validation techniques are available, including face validity, and the use of agreement coefficients. Options for seeking agreement may utilise a panel of experts, or dialogue among co-researchers.	Content validation was conducted through dialogue between the researcher and her study leader.

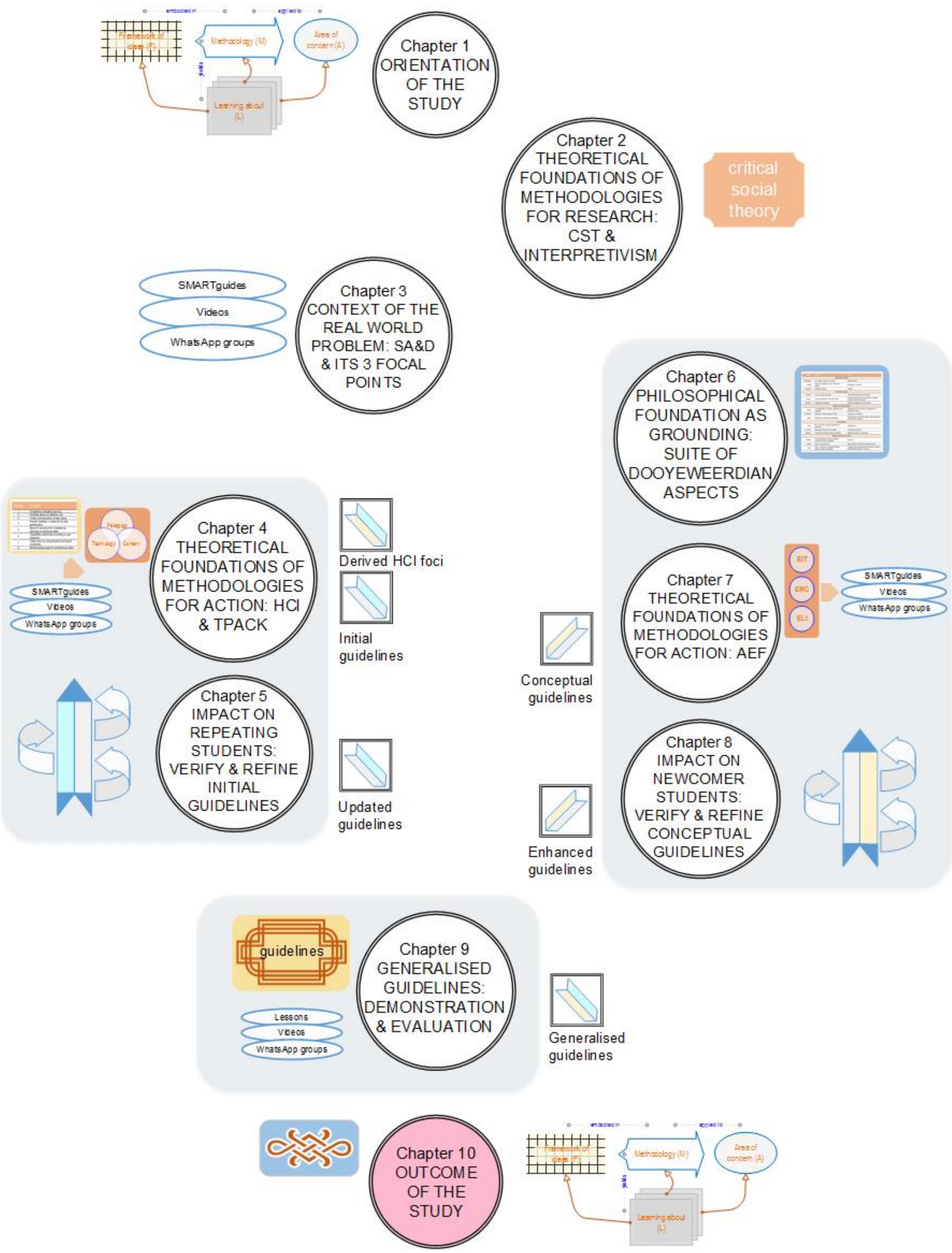
9.10 SUMMARY

The purpose of this chapter was to integrate the updated HCI-TPACK guidelines obtained from initial guidelines, and the enhanced HCI-AEF guidelines obtained from conceptual guidelines to extract generalised guidelines (E03). The generalised guidelines were then used to improve the three focal points and amend the instructional design of SA&D. The improved material and design were then demonstrated to the current contingent of SA&D students for the purpose of evaluation and the validation of the intervention.

Five steps of AR were followed in this intervention of demonstration and evaluation of the improvement of the three focal points in a newly designed combined class accommodating all students. The purpose was to emancipate all students, to enable them to reach their full potential. The generalised guidelines were utilised to amend the three focal points, and then evaluated for this purpose. The demonstration of the three focal points were related to the generalised guidelines, to show, by means of visual material obtained from the developed tools, how the guidelines were incorporated.

With this third AR cycle completed, the empirical work of this study is finalised. The next chapter concludes this study.

Guidelines for the use of technology in HE based on HCI principles from a Dooyeweerdian perspective



10 OUTCOME OF THE STUDY

10.1 INTRODUCTION

The purpose of this study is to develop guidelines for the use of technology in higher education, based on human computer interaction principles, from a Dooyeweerdian perspective.

With this primary objective achieved, this chapter concludes the study. Human computer interaction principles obtained from extant research have been used to obtain derived Human Computer Interaction foci. Two frameworks, the framework for technological, pedagogical, and content knowledge interaction, and the aspectual engagements framework has been utilised in two action research cycles to compile, verify, and refine guidelines in parallel, and to improve the systems analysis and design classes for repeating and newcomer students. In a third action research cycle, the generalised guidelines, the product of this study, has been used to amend the three focal points of instructional design, formative guidance, and summative assessment for the purpose of demonstration and evaluation. In addition, the instructional design of systems analysis and design has been improved to accommodate the combined class of all students.

In subsequent sections, this chapter focuses firstly on the elements which are relevant to this study (§10.2). A summary of the research is provided (§10.3), followed by the outcome of this study (§10.4). The elements of this study is then reflected upon (§10.5), with an evaluation of this study regarding critical social research, which follows (§10.6).The closure of this study concludes the chapter and the study (§10.7).

10.2 ELEMENTS RELEVANT TO THIS STUDY

Throughout this study, the refined Checkland and Holwell (1998b:23) model is directing the research plan (Figure 10.1). The focus of this chapter is the learning which occurred with regards to the framework of ideas (F: F_{A+I} & $F_{\mathbf{A}+I}$), the methodology (M: M_R & M_{PS}), and the real-world problem (P), solved in the area of concern (A). Contributions are expected regarding the suite of Dooyeweerdian aspects on F, action research (AR), the framework for TPACK interaction, the aspectual engagements framework (AEF), human computer interaction (HCI) principles and the three focal points on M, as well as the three focal points as representation of using technology on A, within the context of teaching technology content on P.

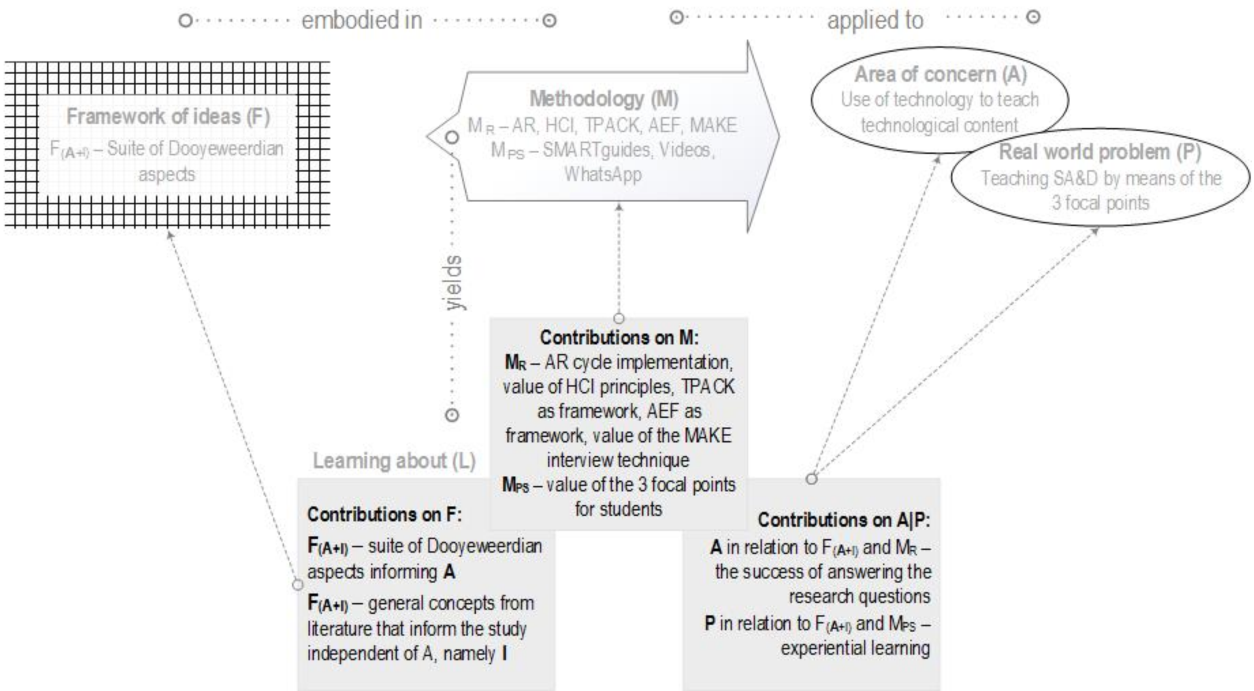


Figure 10.1: The elements relevant to this chapter

10.3 SUMMARY OF THE RESEARCH

The research conducted is summarised here. Chapters are grouped into the context of the study (Chapters 1-3), the AR cycle with its focus on repeating students (R) (Chapters 4 & 5), the AR cycle with its focus on newcomer students (N) (Chapters 6 & 8), and the AR cycle with its focus on the combined class (C) (Chapter 9). The highlights of the study in terms of the objectives, processes, and results are reiterated to provide a succinct account of the progress of the study.

10.3.1 Context of the study

The research design discussed in Chapter 2, and presented at the start of each chapter as a visual reminder of the study, has been utilised to present only the chapters relevant to a particular sub-section. Figure 10.2 shows the context of the study, including Chapter 1, orientation of the study, Chapter 2, theoretical foundations of methodologies for research: critical social theory (CST) and interpretivism, and Chapter 3, context of the real-world problem: SA&D and its three focal points.

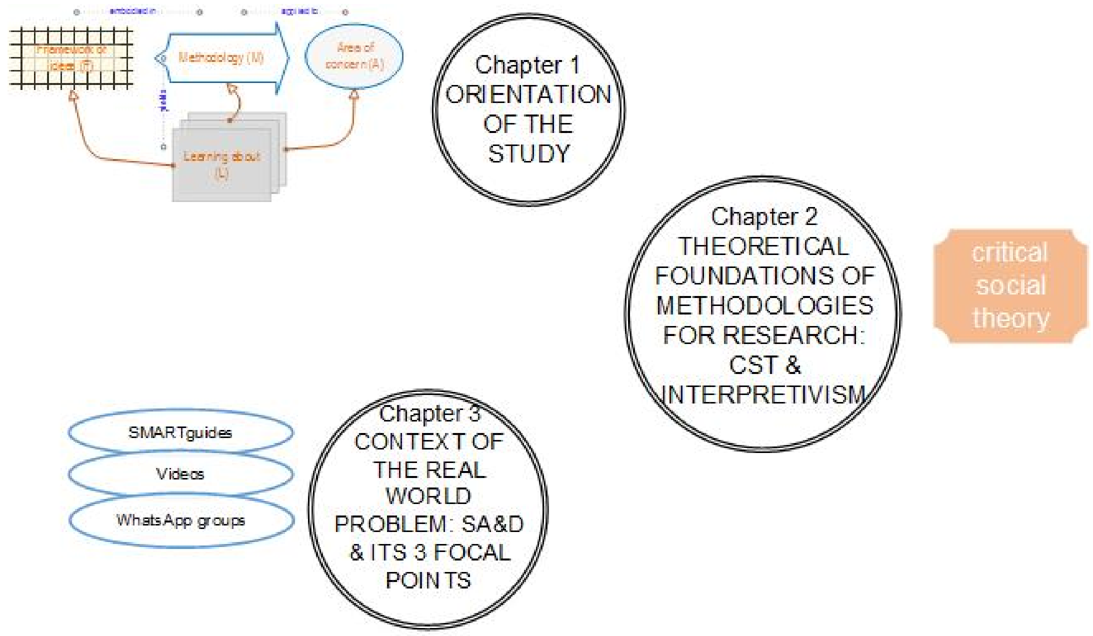


Figure 10.2: The context of the study

Chapter 1, orientation of the study

The study was introduced and the audience made acquainted with the concepts key to the study, the prevalent problem, the relevant elements, its objectives, the research design, and ethical considerations. The objectives set for this study is listed here.

The objectives of the study

The objectives in this study, include an overarching primary objective, with theoretical reflective, and empirical objectives supporting it:

- **Primary objective.** To present derived guidelines for the use of technology in higher education based on HCI principles, from a Dooyeweerdian perspective.
- **Theoretical objectives**.

  T01. To explore the ***extant IS paradigms*** with its corresponding methodologies, methods, and techniques to determine the suitable research design(s) for the study.

  T02. To enquire the potential integration of technology into teaching and learning, to enhance academic success. As guiding lens the ***HCI principles*** is used, while the ***framework for TPACK*** is investigated in support of the HCI principles.

  T03. To investigate how the ideas and specifically the ***fifteen modal aspects of Dooyeweerd*** can be used to gain understanding of the use of technology to learn. The suitability of the ***AEF***, which is based on the suite of modal aspects developed by

Dooyeweerd, as methodology to ascertain the successful integration of technology into teaching and learning, is determined.

- **Reflective objectives**.

  R01. To place the study in context: ***the student***, who needs to be emancipated to reach his/her full potential, stands central to this study; *the* ***subject content of SA&D***, which needs to be improved; and the three technological instruments – represented by ***the three focal points*** of instructional design, formative guidance, and summative assessment incorporated, to enable the extraction, verification, and refinement of guidelines.

  R02. To use the three focal points of this study to make sense of the application of technology in education:

  - To extract a list of ***derived HCI foci*** applicable to this study - from extant literature, on HCI principles extracted in T02.
  - To utilise the framework for TPACK interaction, discussed in T02, on the derived HCI foci to assimilate ***initial guidelines***.

  R03. To utilise the AEF, discussed in T03, which suggests aspectual reflection, to analyse the three focal points, and make sense of this study:

  - To prepare an HCI analysis matrix, by using the AEF, discussed in T03 which suggests the use of an aspectual checklist to identify gaps in the derived HCI foci obtained in R02.
  - To employ aspectual analysis, as discussed in T03, on the derived HCI foci to extract ***conceptual guidelines***.

- **Empirical objectives**.

  E01. To apply the five-step AR cycle to guide the verification and refinement of the initial guidelines obtained in R02 – with the concurrent purpose to improve the experience of ***repeating*** students. The three focal points stand central to this cycle. The evaluation is guided by the SA&D implementation, the derived HCI foci, and TPACK during the AR cycle. ***Updated guidelines*** are obtained. The cycle utilises applicable qualitative data gathering and analysis techniques.

  E02. To apply the five-step AR cycle to guide the verification and refinement of the conceptual guidelines obtained in R03 – with the concurrent purpose to improve the experience of ***newcomer*** students. The three focal points stand central to this cycle. The evaluation is guided by the SA&D implementation, the derived HCI foci, and AEF during the AR cycle. ***Enhanced guidelines*** are obtained. The cycle utilises applicable qualitative data gathering and analysis techniques.

E03. To extract the ***generalised guidelines*** from the updated guidelines obtained in E01, and the enhanced guidelines obtained in E02. The five-step AR cycle is then followed to guide the improved instructional design of SA&D, as well as the demonstration of the amended three focal points – according to the generalised guidelines. The concurrent purpose is to improve the experience of ***all SA&D students***. The evaluation tests the success of the intervention. The cycle utilises applicable qualitative data gathering and analysis techniques.

Chapter 2, theoretical foundations of methodologies for research: CST & interpretivism

The exploration of extant IS paradigms with its corresponding methodologies, methods, and techniques in order to determine the suitable research design(s) for the study, was the theoretical objective (T01). The organised use of rational thought; with reference to a framework of ideas, a methodology and an area of concern was used to guide the study. The five step AR method as used in a CST framework, with interpretivism supporting it, has been determined as the method to guide this research. Two metaphysical assumptions of CST, which were discussed in more depth in Chapter 2 (§2.4.3), guided this research:

- *Ontological assumption*: history establishes social realities through people who develop and reproduce it. With people resisting change, the critical researcher has the responsibility to create awareness regarding dominance and change for the purpose of emancipation.
- *Epistemological assumption*: critical research has the aim of social critique, this critique should focus on conditions restricting the situation, the purpose being to emancipate people to development their full potential.

As is anticipated in CST, qualitative data with its corresponding analysis methods informed the study. The set of six principles used when conducting critical studies in IS (Myers & Klein, 2011:25), along with the set of seven principles used when conducting and assessing the quality of interpretive field studies in IS (Klein & Myers, 1999:67), guided data collection and analysis of the study and is discussed in Section 10.6.

Chapter 3, context of the real-world problem: SA&D & its three focal points

The objective of this chapter was to place the study in context (R01). The student and his/her emancipation in order to reach his/her full potential, stand central to this study, with the SA&D subject modules and the three technological instruments of instructional design (the SMARTguides as electronic study guides), formative guidance (Videos), and summative assessment (WhatsApp groups as mobile instant messaging application choice) as focal points, to be improved to achieve this emancipation. These three focal points stand central in facilitating the extraction, verification, and refinement of the generalised guidelines.

With all higher education subject modules including the key foci of instructional design, formative guidance, and summative assessment, it is anticipated that the three focal points of SA&D would be useful in any subject, and that the generalised principles would therefore be applicable in the context of technology used in higher education.

10.3.2 AR Cycle R: updated HCI & TPACK guidelines

Figure 10.3 reflects the chapter leading to and the chapter in which AR Cycle R is performed, namely Chapter 4, theoretical foundations of methodologies for action: HCI & TPACK, and Chapter 5, impact on repeating students: verify & refine initial guidelines.

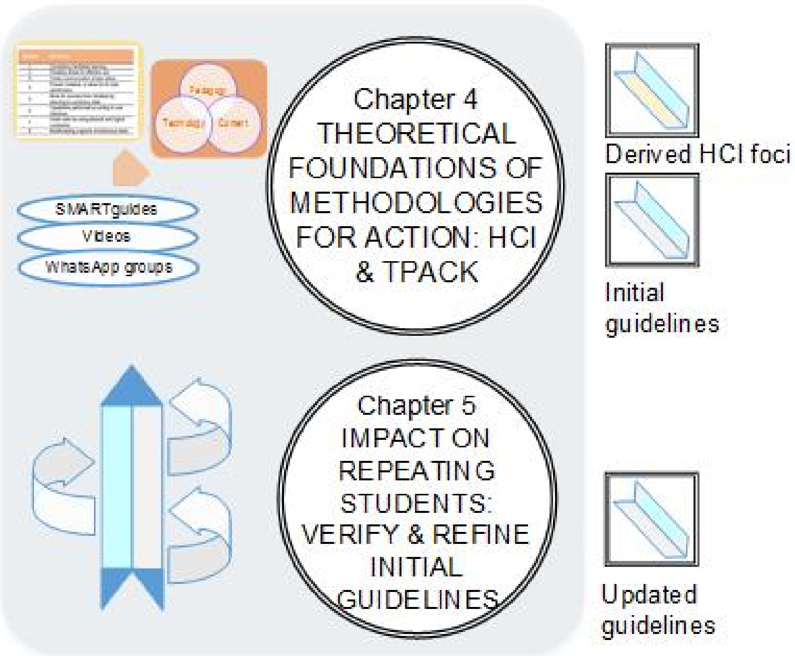


Figure 10.3: AR Cycle R

Chapter 4, theoretical foundations of methodologies for action: HCI & TPACK

The objective of this chapter was twofold (T02 & R02). It debated the inclusion of particular HCI principles from extant literature in this study. The derived HCI foci is the list of resultant extracted guidelines. The derived HCI foci is utilised in the chapter under discussion, as well as in Chapter 7. The original table listed in Chapter 4, Table 4.3, is shown as incorporated in the final generalised guidelines in Figure 10.6 in Section 10.4 – in green. In this final representation of the guidelines, the description of the derived HCI foci has been omitted here.

The three focal points were then mapped to the derived HCI foci, to facilitate understanding and determine its value in the context of the study. In addition, the chapter investigated the framework for TPACK interaction and its interaction as a model to support the verification and refinement of the derived HCI foci. This was done by first mapping the three focal points to TPACK, to facilitate understanding and determine its value in this context, and then to map the derived HCI foci to TPACK. The initial guidelines, listed in Chapter 4, Table 4.8, is the result of this process.

The initial guidelines were important in the progression of this study, with its verification and refinement due in Chapter 5.

Chapter 5, impact on repeating students: verify & refine initial guidelines

The implementation of an AR cycle in the context of SA&D teaching and learning of repeating students, was the objective of this chapter (E01). The literature addressed in the preceding chapter informed the AR cycle. The intention was to improve the experience of repeating students, and enable the verification and refinement of the initial guidelines.

Data collection was done by means of unstructured interviews. The interviews conducted in AR Cycle R included five alumni SA&D students who repeated SA&D I at least once. It is important to note that it is not anticipated that the researcher will be a lecturer of participants in the future. These participants were approached by the researcher, upon which they all agreed to participate. The actual interviews were conducted in an atmosphere of amiability.

Data analysis was done by means of the content analysis process suggested by Elo and Kyngäs (2008:110), including three approaches. In AR Cycle R, the ***analysis matrix*** approach was followed. Open coding was utilised in this AR cycle for small sections of the analysis, specifically those not concerning the formation of the guidelines.

The formulation of the updated HCI-TPACK guidelines, originally listed in Chapter 5, Table 5.13, is shown as incorporated in the final generalised guidelines in Figure 10.6 in Section 10.4 – in blue.

The updated guidelines were important in the progression of this study with its planned incorporation into the generalised guidelines to be formed in Chapter 9.

10.3.3 AR Cycle N: enhanced HCI & AEF guidelines

Figure 10.4 reflects the two chapters leading to and the chapter in which AR Cycle N is performed, namely Chapter 6, philosophical foundation as grounding: suite of Dooyeweerdian aspects, Chapter 7, theoretical foundations of methodologies for action: AEF, and Chapter 8, impact on newcomer students: verify & refine conceptual guidelines.

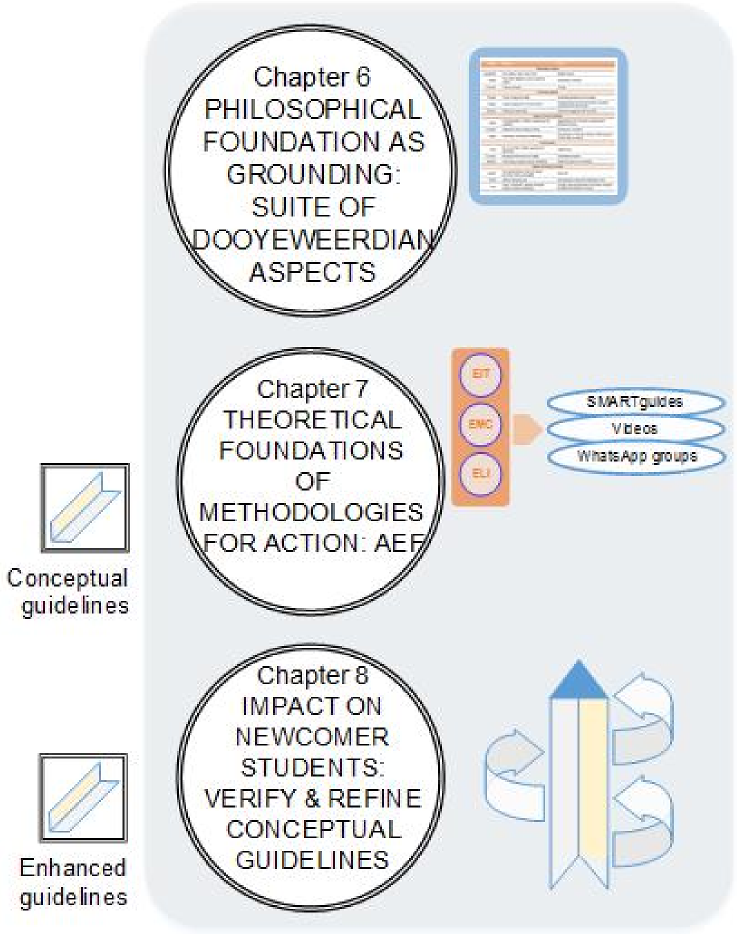


Figure 10.4: AR Cycle N

Chapter 6, philosophical foundation as grounding: suite of Dooyeweerdian aspects

The objective of this chapter was to investigate the philosophical framework, developed by Dooyeweerd, including his 15 modal aspects for understanding reality, used in this study (T03). Modal aspects allowed the researcher to focus on what matters; it becomes possible to describe all aspects of reality in terms of the 15 modalities, and it is applicable to the everyday lives of ordinary people. Each modality has a kernel of meaning, which may inherently relate to other aspects by means of retrocipation or anticipation. The 15 modal aspects, as listed in Chapter 6, Table 6.11, is shown in Table 10.1.

Table 10.1: The 15 modal aspects of reality identified by Dooyeweerd as categorised by Basden (2000); using the good it brings

Aspect	Meaning	Good
	Mathematical aspects	
Quantitative	One, several, many; more or less	Reliable amount
Spatial	Here, there, between, around, inside and outside	Simultaneity, continuity
Kinematic	Flowing and going	Change
	Pre-human aspects	
Physical	Forces, energy and matter	Irreversible persistence and causality
Organic	Living as organisms in an environment	Sustained being and functioning that is not wholly controlled by the environment
Sensitive	Feeling and responding	Interactive engagement with the world
	Aspects of human individual	
Logical	Conceptualisation, clarifying, categorising and cogitating	Independence from the world; conceptual and theoretical thinking
Formative	Deliberate creative shaping of things	Achievement, innovation
Lingual	Expressing, recording and interpreting	Externalisation of intended meaning; referring beyond to whole web of meaning
	Social aspects	
Social	We, us and them; relating, agreeing and appointing	Togetherness
Economic	Managing limited resources frugally	Sustainable prosperity
Aesthetic	Harmonising, enjoying, playing, beautifying	Delight that seems non-necessary
	Aspects of structure of society	
Juridical	Due appropriateness, debt and reward, structures of policy and legality	Due for all
Ethical	Attitude, self-giving love	Extra goodness, beyond the imperative of due
Pistic	Vision, commitment, certainty and belief; aspiring, trusting, worshipping	Courage, hope and openness to the Divine; change in the attitude and direction of society

The knowledge gained from this chapter, informed the next, in which the AEF, which builds on the work of Dooyeweerd, was inquired as method to compile, verify and refine HCI guidelines.

Chapter 7, theoretical foundations of methodologies for action: AEF

The objective of this chapter, was the investigation of the AEF (T03) as enabler of the analysis of the derived HCI foci obtained in Chapter 4. In this chapter the application of the AEF manifested in the aspectual reflection of the derived HCI foci, in the context of the three focal points of this research (R03). The product of this process is conceptual guidelines for the use of technology. The original list can be found in Chapter 7, Table 7.10.

The conceptual guidelines were important in the progression of this study, with its verification and refinement due in Chapter 8.

Chapter 8, impact on repeating students: verify & refine conceptual guidelines

The implementation of an AR cycle in the context of SA&D teaching and learning of newcomer students, was the objective of this chapter (E02). The literature addressed in the preceding two chapters informed the AR cycle. The intention was to improve the experience of newcomer students, and enable the verification and refinement of the conceptual guidelines.

Data collection was done by means of unstructured interviews. The interviews conducted in AR Cycle N, included six alumni SA&D students who passed SA&D I on the first attempt. It is important to note that it is not anticipated that the researcher will be a lecturer of participants in the future. These participants were approached by the researcher, upon which they all agreed to participate. The actual interviews were conducted in an atmosphere of amiability.

Data analysis was done by means of the content analysis process suggested by Elo and Kyngäs (2008:110), including three approaches. In AR Cycle N, the ***structured analysis matrix*** approach was followed. Open coding was utilised in this AR cycle for small sections of the analysis, specifically those not concerning the formation of the guidelines.

The formulation of the enhanced HCI-AEF guidelines, originally listed in Chapter 8, Table 8.40, is shown as incorporated in the final generalised guidelines in Figure 10.6 in Section

10.4 – in yellow. The enhanced HCI-AEF guidelines include the recommendation made in Section 9.6.4.

The enhanced guidelines were important in the progression of this study with its planned incorporation into the generalised guidelines to be formed in Chapter 9.

10.3.4 AR Cycle C: generalised guidelines

Figure 10.5 reflects Chapter 9, generalised guidelines: demonstration & evaluation, in which the generalised guidelines were formed from the updated and the enhanced guidelines.

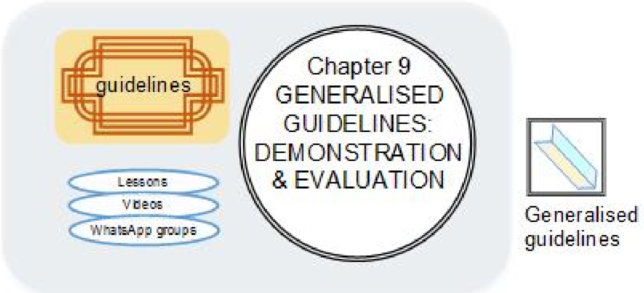


Figure 10.5: AR Cycle C: demonstrate & evaluate generalised guidelines

Chapter 9, generalised guidelines: demonstration & evaluation

This chapter reported on the integration and consolidation of the results regarding the extraction of guidelines from the two parallel AR cycles discussed in Chapters 5 and 8 to obtain generalised guidelines (E03).

The groupings suggested by the TPACK framework, direct the guidelines, with some spheres including some of the derived HCI foci as listed in the updated guidelines. In addition, the enhanced guidelines supported the updated, derived HCI foci. All updated and enhanced emphases, have been removed.

Data collection was done by means of written interviews. The interviews conducted in AR Cycle C included nine current SA&D II students, of which three repeated SA&D at least once. It is important to note that the researcher was not involved with SA&D II at the time, and that in the case of these participants, it is not anticipated that the researcher will be a lecturer of participants in the future. Six participants were approached by the researcher, upon which they all agreed to participate. Three participants volunteered to participate in the written interviews.

Data analysis was done by means of the content analysis process suggested by Elo and Kyngäs (2008:110), including three approaches. In AR cycle C, the ***open coding*** approach was followed.

The generalised guidelines as listed in Chapter 9, Table 9.3, is shown as incorporated in the final generalised guidelines in Figure 10.6 in Section 10.4.

Subsequently, the generalised guidelines were used to guide the demonstration of the three improved focal points. A summary of the generalised guidelines applicable to each of the three focal points, was shown in Table 9.13. The demonstration and evaluation were successful. Only one answer from three questions (one question for each of the focal points) was indicating a negative experience, all other answers indicated that the focal points are of value.

With the demonstration and evaluation, it became clear that it was not possible to link all focal points of this study to all of the generalised guidelines. For this reason, the references to "*all three focal points*" in the generalised guidelines, specifically in the social and lingual modalities, are removed. The amended wording is:

> So: Social interaction should be moderated in an academic implementation. All technology tools should accommodate a diversity of cultures of its users to ensure widespread use.
>
> Li: Engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.

The final version of the generalised guidelines is listed in the subsequent section.

10.4 OUTCOME OF THIS STUDY

The outcome of this study realised through the extraction of a set of generalised guidelines, and the emancipation of students to reach their full potential. The research questions asked in the three AR cycles of this study are as follows:

The research question stated in Chapter 5 for the AR Cycle R intervention, focused on utilising the three focal points of SA&D to emancipate repeating students:

How can the lecturer utilise the three focal points, each with its particular niche in SA&D, to create a limber environment that will ensure that especially the repeating students reach their potential?

The research question stated in Chapter 8 for the AR Cycle N intervention, focused on utilising the three focal points of SA&D to emancipate newcomer students:

How can the lecturer utilise the three focal points, each with its particular niche in SA&D, to create a limber environment that will ensure that especially the newcomer students reach their potential?

The research question stated in Chapter 9 for the AR Cycle C intervention, focused on utilising the three focal points of SA&D to emancipate a combined class with newcomer and repeating students:

How can the lecturer amend the three focal points, each with its particular niche in SA&D, to create a limber environment that will ensure that the combined class of repeating & newcomer students reach their potential?

10.4.1 Generalised guidelines

The generalised guidelines were extracted during the implementation of the three AR cycle interventions. These guidelines, with the amendments suggested in the previous section, is incorporated in the final generalised guidelines in Figure 10.6. The green blocks reflect the derived HCI foci – as guidelines – component, the blue blocks the updated guideline component, and the yellow blocks the enhanced guideline component. The text has been adjusted to enable all the guidelines to fit on one page.

10.4.2 Emancipation of SA&D students

The three focal points of this study stood central to the extraction of the generalised guidelines, but findings from this study suggest that they are also of utmost importance in the teaching and learning success of SA&D. In addition; although participants emphasized the value of the three focal points, they also indicated potential for improvement in the broader SA&D environment.

Updated guideline

Content knowledge: Content should be presented in small portions which are easily and directly accessible, with reference to more in-depth sources of knowledge to address more complex problems.

Pedagogical knowledge: The identification of teaching (and learning) approaches is paramount in guiding the thought processes necessary to obtain a solution in the SA&D context: how to analyse a problem; where to start solving a problem; and how to verify one's solution.

Technological knowledge: The inclusion of technology tools requires ensuring its accessibility and therefore guidance in its use, and support regarding its download to a variety of platforms. Additional non-technical measures should be considered when utilising technology tools not intended for teaching and learning. The HCI foci listed are applicable to the technology sphere.

HCI focus	Enhanced guideline		
Consistency and familiarity facilitate learning.	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement are established between components.		
Flexibility allows for effective use.	So: Social interaction should be moderated in an academic implementation. All technology tools should accommodate a diversity of cultures of its users to ensure widespread use.	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.	
Prevent mistakes, or allow for its clear identification.	Li: Engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.	A: Technology tools should be designed in a way which is aesthetically pleasing and to facilitate understanding.	
Allow for recovery from mistakes by returning to a previous state.	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.		
Capabilities performed according to user intentions.	Et: The continuous (and repetitive) use of technology tools across a variety of devices – according to the needs and means available to a user, should facilitate understanding whenever a user is in need of it.	Pi: Technology tools should facilitate in-depth learning which should affect students in the classroom, as well as beyond the classroom in the workplace.	
Multithreading supports simultaneous tasks, multimodal dialogue includes multiple human senses.	Ph: The use of tools may energise users, while its availability acts as a backup support. In addition it should support the visual, and the auditory by presenting clear displays and sound.	Se: Colour and sound, combined with a strong message which clearly conveys the purpose of a concept, may facilitate understanding. An academic focus should be encouraged.	Lo: The coordination of tools should allow the logical progression of the presentation of material according to the user's needs.
Timely communication of task status.	K: Interactivity should be applied in a way which the specific tool allows. Effort should be made to ensure that fluid movement are established between components.	Li: Engagement with content relies on the lingual. All possible communication mechanisms (pictures, videos, etc.) should be encouraged, to convey the intended message and to ensure consistency.	

Updated guideline

Pedagogy-content knowledge: Content should be presented in small portions that is easily and directly accessible, with reference to more in-depth sources of knowledge to address more complex problems. The HCI foci listed are applicable to the pedagogy-content intersection.

HCI focus	Enhanced guideline				
Guide users by using physical and logical constraints.	Q: Only the MIMA groups have a size limitation in terms of members accommodated. In all technology tools a smaller size (page, video, or group) is advisable. With this in mind, all applicable concepts should be included in a tool, no matter the number. Examples should cover from the very simple to complex issues.	Sp: With all types of devices considered, special attention should be given to mobile devices – to accommodate technology tools. Because of its small screens, it is imperative to compile compact chunks of information.	O: Units of material should be compact, to present contained information designed to engage, and to allow for breaks. F: The integration of electronic and other tools may support the planning for learning and guidance which should be provided by an educational technology tool.	Ec: Although technology tools may include more material than physical tools, due to its electronic nature, storage space and data transfer do incur costs. Therefore technology tools should be compact.	J: Users should want to access an educational tool which fulfils its purpose and provide guidance, information, motivation and/or clarity according to the immediate need – to ensure that what is due for all is made available.

Updated guideline

Technology-content knowledge: Although technology typically does not constrain the transfer of large parts of material, the presentation of small portions of interactive in-context material to direct learning when needed, should be the focus when using it for teaching and learning purposes.

Technology-pedagogical knowledge: Technological support should allow students to extend their access to their lecturer and peers beyond physical class times.

Technological-pedagogy-content knowledge: In support of a lecturer, technology should be a channel for content presented in a way through which students will best internalise concepts.

Figure 10.6: Final generalised guidelines

10.4.2.1 SMARTguides evolving to become eFundi Lessons

Although all participants who participated in the parallel AR cycles, referred to the SMARTguides for some academic purposes, most felt that they under-utilised it. Participants indicated that greater interactivity, more information on assignments and the group project, its use to contribute to marks, and its availability on mobile devices would contribute to its usability. During the last AR cycle, participants commended the interactivity, logical organisation of small learning chunks, and provision of immediate feedback of Lessons, which was encouraging, since it addresses some of the concerns associated with SMARTguides. Valid requests for improvement were to make provision for the printing of embedded documents, and to include more examples and fun activities.

10.4.2.2 Videos

In terms of using videos to make sense of material in SA&D, participants represented the full spectrum of usage, namely some being very reliant on videos, to others not at all. Valid requests for improvement were to ask lecturers of SA&D across campuses to produce videos, to use real-life examples in videos, to provide for more than one video per challenging concept, each on a different level of difficulty, and to include videos on the analysis & design of agile applications. These difference in the use of videos highlights the importance of naming videos according to each one's focus to allow selective viewing, making a timeframe breakdown per video available to facilitate repeated viewing of parts of a video, and compiling a video directory of all available videos to make students aware of the videos.

10.4.2.3 WhatsApp as MIMA

Although all participants found the WhatsApp groups of value, some participants indicated that they are confident in the use of the tool, while one other participant utilised it by asking friends to ask her questions. A third group joined the WhatsApp groups, but did not post messages, they only read the messages.

Participants recognised that a need may exist to guide academic intent with basic rules. At the same time they indicated that more effort should be made to involve the participation of students on the groups. Possibly this may be addressed by the lecturer posting more questions to keep the group active. Valid requests for improvement were to amend the summative assessment focus of the groups to post messages to motivate students, provide guidance on project work, supply information on what needs to be completed in class, explain difficult concepts, and make provision for one-question-a-day. Such a diversity of needs may necessitate the formation of more than one group. Participants indicated that they also rely on WhatsApp to facilitate the communication in their project groups. In this regard they indicated that it may assist future students to be made aware of similar tools with more functionality, for example Discord, which combines features of WhatsApp and Skype to facilitate voice conferencing, a Google Drive account which may be linked to a WhatsApp group, which would facilitate the sharing of files and its version control of documents, and any software which facilitates version control of developed programs.

10.4.2.4 Beyond the three focal points

Regarding the inclusion of technology applications other than the three focal points, two suggestions were made, namely the utilisation of websites to support each study unit, and the inclusion of quizzes to learn terminology and definitions.

10.4.2.5 SA&D instruction

Participants relayed advice to students starting with SA&D – from the perspective of someone who has already done the subject. Participants indicated that hard work is necessary to take up the challenge presented by SA&D: with some actions non-negotiable, namely acknowledging the link between assignments and the group project, completing weekly project tasks, and preparing for assessments diligently. The fact that keeping a positive mind-set goes hand-in-hand with hard work, has been emphasized. Awareness regarding the following may keep the new SA&D student focused: highlighting the fact that SA&D is directly tethered to the workplace, with one participant suggesting exposure to IT companies, and another indicating the simulation of the work environment through project work.

10.5 REFLECTION ON THE ELEMENTS RELEVANT TO THIS STUDY

The organised use of rational thought (Checkland & Holwell, 1998b:23), was introduced in Chapter 1 (§1.4), and expanded in terms of the elements applicable to a critical study, in Chapter 2 (§2.6.2.3). It prominently guided every chapter in this study.

The amended version listed in Chapter 1 (Figure 1.3), of the original figure listed in Chapter 1 (Figure 1.2), is used to guide the reflection of this study. It is shown in Figure

10.7. The focus is on the learning (L) about the elements of the intellectual framework (F), the methodology (M), and the area of concern (A).

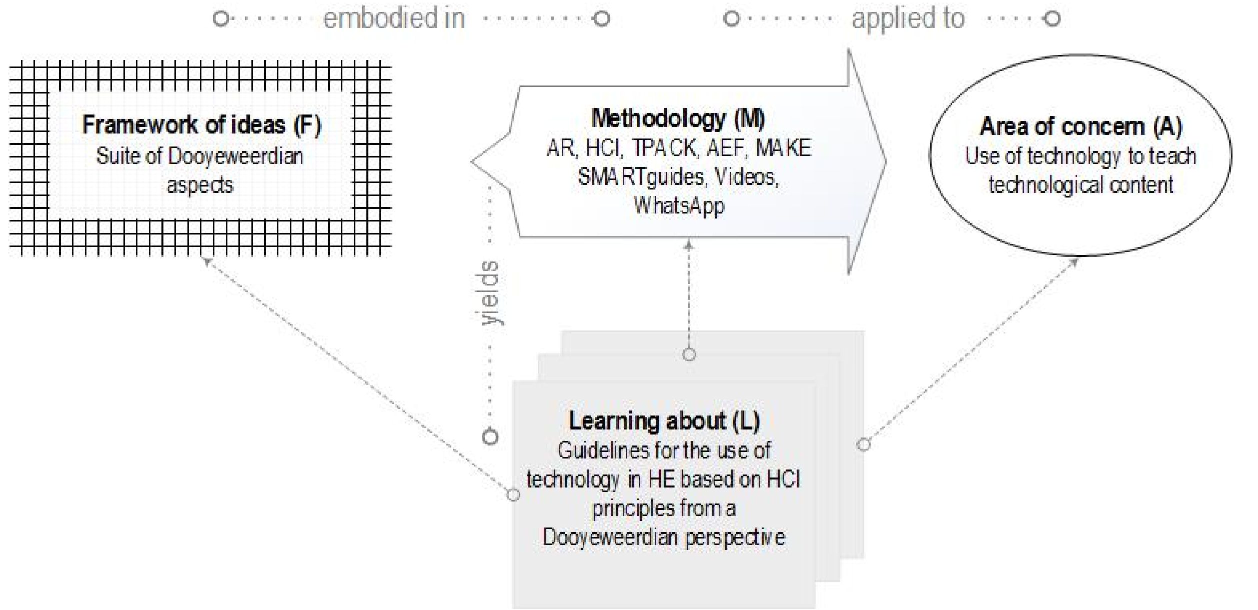


Figure 10.7: The elements relevant to this study

10.5.1 Learning about the framework of ideas (F)

In this study, the philosophy of Dooyeweerd represents the framework of ideas, and its novelty is reflected upon.

The Dooyeweerdian philosophy is not generally applied in IS, and although the AEF is one of five frameworks based on the philosophy of Dooyeweerd suggested and designed to be applied in IS, its application is relatively new.

This study, where AEF is applied to an educational setting, is also a new application. With the HCI focus of this study, it has a strong link with the original terminology used by Basden to describe AEF. The framework was initially called the Human Use of Computers Framework (HUCF), with the three functionings:

- Human-computer interaction (HCI), in AEF referred to as engaging with interface and technology (EIT),
- Engagement with represented content (ERC), in AEF referred to as engaging with meaningful content (EMC), and
- Human living with computers (HLC), in AEF referred to as engaging in life with IS (ELI).

Of the five frameworks suggested by Basden (2008:27), the AEF addressed the essence of the research, namely how one integrates computers with people's lives. Such an integration may occur at work, at home, but also in an individual's academic life.

The use of Dooyeweerd supports CST. The Shalom principle, which is inherent to the philosophy of Dooyeweerd, represents emancipation, but has a wider reach (Basden, 2018:206). The modal aspect of the juridical encapsulates its meaning ("*that which is due to all*"). The formative and ethical modalities support the juridical aspect in this context, where the former represents the power relations (achievement), and the latter an attitude underlying achievement (either self-interest, or generosity). For instance, students may easily be overwhelmed by the amount of work they have do in combination with the pace at which it has to be done. This is where the lecturer can make a difference; to be there for her students, to wait for their call, to (use technology to) break down that which seem huge and overwhelming into small bits, and to convey material in a simplified way, which may enhance the successful completion of a subject module. But, the implication of this is that the Dooyeweerdian philosophy responds to reality, and does not shape it as is the intention with CST. The Dooyeweerd philosophy focuses on that which is (understanding), and not what should be (emancipation). While keeping this contradiction in mind, the researcher has the intention to help her students to become better systems analysts, systems designers, and system developers. Therefore, in combination with the Dooyeweerdian philosophy, the two research paradigms, namely CST – having the purpose to emancipate, and Interpretivism – with the intention to facilitate understanding, supporting CST, served this purpose.

10.5.2 Learning about the methodology of existing research areas (M)

Multiple frameworks, techniques, and methods were utilised in this study. It was valuable to have knowledge of the HUCF, while implementing the AEF. The AEF incorporates HCI, which is now referred to as engaging with interface and technology functioning, as a reminder of the underlying HCI functioning linking with the HCI principles.

The AEF has been reflected upon in the previous section. Here, it is considered in terms of its influence on the use of TPACK. Inherent to the design of the AEF, is the reflective processes of the aspectual checklist, aspectual analysis, and fir trees. These processes allowed the researcher to become familiar with the research before data was collected. Data collection then served to verify the findings. In this research, verification has been extended to include refinement as well, to allow the incorporation of changes to the guidelines which were central to this study.

The framework for TPACK interaction is treated as a model by its creators, and the spheres of the model and its intersections are only described. In the application of TPACK in this research, the analysis prescribed by the AEF to occur before data collection, has also been applied to the AR Cycle R intervention. This enabled researcher familiarity with the research, and allowed verification, and refinement, of the initial guidelines in order to obtain updated guidelines.

Although consideration was given to using the updated guidelines derived from AR Cycle R as the point of departure for AR Cycle N, it was found that the approaches differed too much for this to be implemented, and it was decided to revert to the derived HCI foci for AR Cycle N as well. It would not be appropriate to compare the results from the parallel cycles, since the students in the two classes differ regarding their needs and approaches on a deep level. In addition, it was found that the updated and enhanced guidelines complement one another. The fact that the AEF (Basden, 2018) evolved from the Human Use of Computers Framework (Basden, 2008), with HCI one of the functionings of the latter, facilitated the integration of the two sets of guidelines. The updated HCI-TPACK guidelines included the derived HCI guidelines in its structure, while the enhanced HCI-AEF guidelines described the derived HCI foci. By integrating the two sets of guidelines, the latter set enriched the former.

In this study, the five characteristics suggested by Churchman contributed much. The researcher started the contextualisation of the research, as well as each AR cycle by considering its purpose, the environment, available resources, prevalent components, and its management.

These considerations allowed the researcher to approach each new SA&D cycle in an informed and structured way. In support of Churchman, the suite of Dooyeweerdian modalities moved the focus of the lecturer away from the constraints of the environment. The modalities allow one to view the world with all its detail, by considering every aspect, but it also gives one a bird’s eye view by highlighting what is important. It becomes a tool in the hand of the problem solver – to respond to challenges in a creative way, instead of trying to control that which is outside one’s jurisdiction.

The environment of any research setting impacts decisions, since it determines the parameters of decisions that can be made by a researcher. In this particular study the constraint of an environment with class sizes larger that the available practical laboratories, could only be solved by splitting the class. At the time it was decided that having a repeater class and newcomer class, would address the needs of two groups already existing in SA&D. With this arrangement working well, it was anticipated that the status quo would continue, but the implementation of a unitary North-West University (NWU) afforded double the SA&D contact time at the onset of 2019. In addition, the ballooning repeater class, made it more difficult to conduct the class in the repeater class format that prevailed. The growth was due to the #FeesMustFall movement of 2015, which relieved some of the financial constraints experienced by previously disadvantaged students. These two factors left the lecturer with only one decision – to continue with one class, while incorporating the needs of the two groups of students within the single class.

Another example of the environment influencing decisions in the setting of the study, is that of the SMARTguide implementation, a Vaal Campus initiative. With the onset of a unitary NWU, the SMARTguides were no longer supported, allowing a choice between PDF study guides and eFundi Lessons – with Lessons being the option allowing the lecturer to build on the design, and interactivity which was afforded by the SMARTguide.

The interviews conducted during the two AR cycles, were each compiled according to the underlying approaches used, and upon reflection the differences brought insight. The TPACK interviews conducted during AR Cycle R, asked questions formulated according to the meaning of the spheres and its intersections. With this approach, similarities among answers from different participants, occurred. The interviews conducted during AR Cycle N included no formulated questions, but asked participants to relate experiences in the context of the research, according to modalities. Although it was anticipated that most participants would struggle to express themselves using the modalities, this was not the case. Most of the participants could express themselves with multiple examples on each of the modalities. One of the participants (P2) did struggle to find experiences to link to the modalities, and the interviewer was required to use her own examples to prompt the participant. Unfortunately such a situation may subdue the voice of a participant.

It was interesting to find that many of the participants would relate similar issues, but address them in different modalities, with all the modality allocations done correctly. One example addressed the issue of being privileged versus having a disadvantaged background, anticipated to fall within the economic modality, of which many examples did, but not all. This issue with its coding manifestation is relayed in Table 10.2.

Table 10.2: Issue: being privileged versus having a disadvantaged background

Participant	Modality	Code
P1	Economic	After hours I would help peers with resources from eFundi, via WhatsApp
P2	Economic	Many students cannot access eFundi off campus
P3	Physical	If you are well rested, you can focus in class
P4	Economic	I was a privileged student in terms of funding
P5	Economic	One needs to plan to use your data bundle frugally
P6	Spatial	The space where one stays impacts your studies
P6	Organic	Initially I did not care for myself, and could not cope with study demands
P6	Organic	Where you stay influence your energy levels, because traveling is exhausting
P6	Economic	Not having sufficient funding influences your access to technology devices and data

It is clear that the modalities encouraged participants to relay multiple stories of similar events.

The content analysis process suggested by Elo and Kyngäs (2008:110) was utilised in this research. It allows for three approaches, namely open coding, analysis matrix, and structured analysis matrix, as represented in Table 10.3.

Table 10.3: Content analysis process as adapted from Elo and Kyngäs (2008:110)

	Content analysis process		
Phase	(1) Open coding	(2) Analysis matrix	(3) Structured analysis matrix
Preparation	Select unit of analysis		
	Making sense of the data		
Organising	Open coding	Develop analysis matrix	Develop structured analysis matrix
	Grouping	Gather data by content	Data coding according to categories
	Categorisation	Grouping	Comparison to earlier studies
	Abstraction	Categorisation	- -
	- -	Abstraction	- -
Report	Model conceptual system, conceptual map, or categories		

Although open coding was utilised in both of the parallel AR cycles for small sections of analysis, analysis matrix (2) was primarily applicable to AR Cycle R, structured analysis matrix (3) was primarily applicable to AR Cycle N, and open coding (1) was primarily applicable to AR Cycle C.

10.5.3 Learning about the area of concern (A)

The SA&D subject modules, with the three focal points of instructional design, formative guidance, and summative assessment, made up the area of concern.

With WhatsApp specifically designed and developed as a social tool, it is not perceived as an academic instrument. This statement has been confirmed during the interviews conducted in this study. In many academic circles WhatsApp is seen as a distraction, something having a negative effect on academic performance (Obi Jude *et al.*, 2019). During interviews in this study, participants shared that their perception of the value of WhatsApp changed with them using it as an academic tool in SA&D, and subsequently they extended its academic use to their project groups, and other subjects.

With the lecturer seeing the value of WhatsApp in the academic context, many of its associated problems have been managed, or overlooked. In the application of the generalised guidelines to the WhatsApp group, many of these problems could be addressed, with significant improvements resulting in student behaviour in 2019. The application of the generalised principles with its incorporated derived HCI foci, TPACK guidelines, and AEF guidelines with its underlying Dooyeweerdian modalities, to WhatsApp, does not change the essence of WhatsApp. It is still a social application, but an application which fits into the world the student is intimately familiar with. In the case of this particular focal point, the application of the generalised guidelines relies less on the derived HCI foci component with its supporting Dooyeweerdian modalities, and more on TPACK – because of its educational focus.

The influence of the environment on decisions emphasises that workers in general, and academics specifically, need to be adaptable to their environment. Since an environment acts as a constraint, with it being a constant, it is necessary for the academic to think creatively about the environment, and to come up with bold solutions to its challenges. Solutions which should contribute to the success of everybody involved.

Although this study has taken place in the context of SA&D, an area within the field of information systems (IS), the related findings are not limited to the context and content of SA&D. With lecturing experience of 35 years, the researcher has taught multiple IS and research methodology subject matter. These subjects included theoretical work (examples of subjects: history of computers, research methodology, and SA&D), where memorising facts, and understanding subject matter is important; practical implementations (examples include programming, data structures, and SA&D), where the application of knowledge and the analysis of problems are important, and project work (such as honours projects, and the SA&D project), where students need to come up with a problem to solve, build a solution, and evaluate the success of the end product. All of these subject modules include the key foci of instructional design, formative guidance, and summative assessment. With this in mind, the three focal points of this study would be useful in any of the mentioned subjects, and the generalised principles applicable to technology used in higher education.

10.6 EVALUATION OF THIS STUDY IN TERMS OF CST

At the start of this study, it was indicated to be embedded in the CST paradigm, with interpretivism as supporting paradigm. This section highlights how the set of six principles to be used when conducting critical studies in IS, as well as the set of seven principles to be used when conducting interpretive field studies in IS, were applied. In addition, the limitations of the study in the context of the underlying paradigm, as well as future work, are considered.

10.6.1 Set of 6 principles to be used when assessing critical studies

The set of six principles to be used when conducting critical studies in IS (Myers & Klein, 2011:25), was related in Chapter 2 (Table 2.2) and is listed again in Table 10.4, to allow reflection upon the application of each. An explanation of each principle is included to guide the reflection.

Table 10.4: Principles for conducting critical research as adopted from Myers and Klein (2011:25), applied to this study

No.	Principle		Explanantion & application in this study
1	Using core concepts from critical social theories	Elements of critique	Critical researchers should organise their data collection and analysis around core concepts and ideas from one or more critical social theorists. *The following core concepts directed the three AR cycle interventions:* • *A technique regarding five characteristics to be considered in the diagnose phase of AR (Churchman, 1968) in all cycles implemented in this study, namely, AR Cycle R in Chapter 5, AR Cycle N in Chapter 8, and AR Cycle C in Chapter 9.* • *The TPACK framework (Mishra & Koehler, 2006), directed the data collection and analysis* of *AR Cycle R in Chapter 5.* • *The AEF (Basden, 2018), based on the suite of Dooyeweerdian modal aspects, directed the data collection and analysis* of *AR Cycle N in Chapter 8.*
2	Taking a value position	Elements of critique	Values such as open democracy, equal opportunity, or discursive ethics are advocated by critical theorists. These values drive principles 4 to 6, the elements of transformation. *The most important value position of this study is that the learning taking place with regard to individual students, cannot be connected to marks earned. It is the belief of the lecturer that examination marks do not give a true reflection of knowledge acquired. With the SA&D subject modules preparing students for many potential job opportunities, the emphasis is on each student developing his or her full potential (Flood & Jackson, 1991:49). With this purpose in mind, students are challenged to gain knowledge and acquire skills beyond their anticipation. This value position is reflected throughout the thesis.*
3	Revealing and challenging prevailing beliefs and social practices	Elements of critique	Critical researchers should identify important beliefs and social practices and challenge them with potentially conflicting arguments and evidence. *Two applications incorporated in this study challenges important beliefs and social practices:* • *With the Dooyeweerdian philosophy not generally applied in IS, the AEF, one of five suggested frameworks based on the Dooyeweerd philosophy and designed to be applied in IS, is applied in this study (Chapters 6, 7 & 8). A reflection of this topic is included in Section 10.5.1* • *The application of HCI principles to MIMAs, something that is not documented well. The evidence can be found in Chapter 4 (Table 4.4), and Chapter 7 (Table 7.8). A reflection of this topic is included in Section 10.5.3.*

No.	Principle		Explanantion & application in this study
4	Individual emancipation	Elements of transformation	Alvesson and Willmott (1992) argue that CST is oriented toward facilitating the realisation of human needs and potential, critical self-reflection, and associated self-transformation. *The intention of this study is to emancipate individuals to reach their full potential; not only the students who enrolled for the SA&D subject modules, but also the author as lecturer and researcher, and to a lesser extent, the student assistants working with the lecturer. This value position is reflected throughout the thesis.*
5	Improvements in society		It is suggested that improvements in society are possible. The goal is to *suggest* how unwarranted uses of power might be overcome, not just reveal the current forms of domination. Most critical theorists assume that social improvements are possible, to different degrees. *Evidence from the AR Cycle R intervention (Chapter 5), states that students who completed the SA&D subject modules, approach subsequent subject modules in their course differently. This finding implies that colleagues offering IS modules to students who are busy with, or have completed the SA&D offerings are impacted as well. Evidence from the AR Cycle N intervention (Chapter 8), states that, after completion of their BSc course, the newly gained attitude, knowledge and skills of students direct their careers.*
6	Improvements in social theories		Critical theorists believe that the theories are fallible and that improvements in social theories are possible, therefore critical researchers entertain the possibility of truth claims arising from alternative theoretical categories competing. This may guide critical researchers in their analysis and interventions. *Two improvements in social theories are forthcoming from this research:* • *The five characteristics to be considered in the diagnose phase of AR (Churchman, 1968), were utilised in Chapter 3, which covered the context of the study, as well as in all cycles implemented in this study, namely AR Cycle R in Chapter 5, AR Cycle N in Chapter 8, and AR Cycle C in Chapter 9.* • *With the implementation of the AEF (Basden, 2018), an intervention (Chapter 8) that has not been done before in an educational environment, new insights came to the fore (Chapter 10).*

10.6.2 Set of 7 principles to be used when assessing interpretive field studies

The set of seven principles to be used when conducting interpretive field studies in IS (Klein & Myers, 1999:67), was related in Chapter 2 (Table 2.2) and is listed again in Table 10.5, to allow reflection on its application. The reader is made aware once more that this study was not intended to be an interpretive field study as such, but these principles were utilised in a pragmatic way to enrich understanding, and ensure the success of the interventions conducted. An explanation of each principle is included to guide the reflection.

Table 10.5: Principles for conducting interpreted field research as adopted from Klein and Myers (1999:72)

Group	No.	Principle	Explanantion & application in this study
Fundamental	1	The fundamental principle of the hermeneutic circle.	All human understanding is achieved by iterating between considering the interdependent meaning of the parts and the whole they form. This principle is **fundamental** to all other principles. *The content analysis process suggested by Elo and Kyngäs (2008:110), was listed in Figure 2.9. It suggested a technique of "making sense of the data" as part of the preparation phase. Its application in the three AR cycle interventions of this study is described in Sections 5.7.1, 8.7.1, and 9.8.1, and applied in the analysis of the data (Chapters 5, 7 & 9).*
Critical reflection	2	The principle of contextualization.	Requires **critical reflection** of the social and historical background of the research setting, the intended audience should be able to see how the current situation under investigation emerged. *The context of the study is addressed in Chapter 3, and the contextual development which occurred during the implementation of the three AR cycle interventions of this study, was discussed in Chapters 5, 7 & 9.*
	3	The principle of interaction between the researcher(s) and the participants.	Requires **critical reflection** on how the data was socially constructed through the interaction between the researcher(s) and the participants. *Interviews were conducted in each of the three AR cycle interventions, with the following considerations deemed important:* • *In total 20 participants were interviewed, of which eight were students who did not pass SA&D I the first time.* • *The researcher was not involved in the teaching of SA&D modules at the time of the interviews, and she does not anticipate being a lecturer of a subject module involving any of these participants.* • *Barring three participants who volunteered to participate in the written interviews of the last AR cycle, all participants were approached by the researcher, upon which they all agreed to participate.*
Philosophical framework	4	The principle of abstraction and generalisation.	Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social interaction. *The three reflective objectives, namely R01 – to place the study in context (Chapter 3), R02 – to apply the three focal points of this study to the derived HCI foci (Chapter 4, Table 4.4) and the TPACK spheres (Table 4.7), and R03 – to apply the three focal points of this study to the derived HCI foci through an aspectual checklist (Chapter 7, Table 7.4 & Table 7.11) and the AEF through aspectual reflection (Table 7.5 – SMARTguides, Table 7.6 – Videos, Table 7.7 – WhatsApp groups & Table 7.8 Combined), allowed the researcher to apply the principles of the Hermeneutic Circle and contextualization.*
Sensitivity issues	5	The principle of dialogical reasoning.	Requires **sensitivity** to possible contradictions between the theoretical preconceptions guiding the research design and actual findings (*"the story which the data tell"*) with subsequent cycles of revision. *In the findings resulting from each of the AR cycles, "the story that the data tell", is considered. In Chapter 5, it is done implicitly (Table 5.12 & Figure 5.5 & Figure 5.6). In Chapter 8, it is done according to the content analysis process of Elo and Kyngäs (2008:110), who suggested a step to "compare the study to earlier studies" as part of the organisation phase (§8.7.5, every even-numbered table from Table 8.10 to Table 8.38, & Figure 8.5 to Figure 8.8). In Chapter 9, evidence is reflected in Figure 9.18 and Figure 9.19.* *A reflection of this topic is included in Section 10.5.2.*

Group	No.	Principle	Explanantion & application in this study
	6	The principle of multiple interpretations.	Requires **sensitivity** to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study (this is similar to multiple witness accounts even when all tell it as they saw it). *AR Cycle N, with its AEF focus, it was found that many of the participants would relate similar issues, but address them in different modalities. It is clear that the modalities encouraged participants to relay multiple stories of similar events.* *A reflection of this topic is included in Section 10.5.2.*
	7	The principle of Suspicion.	Requires **sensitivity** to possible *"biases"* and systematic *"distortions"* in the narratives collected from the participants. *The relevance of this principle in an interpretive study is debated, and it is viewed as a critical principle (see its discussion in §2.5.2.7). With this study being critical, it was important for the researcher to keep the principle of suspicion in mind.* *A prominent example of the application of the principle of suspicion, occurred in the AR Cycle R intervention, which involved a participant (P3), who did not use the focal points. His interview was included and viewed as of value, because of his disadvantaged background, and his views were interpreted with this knowledge in mind.*

10.6.3 Limitations to the study

In the real world, a student is not the expert when it comes to instructional design, the lecturer is. Therefore the active student is not involved in the AR cycle of five steps including the identification of problems (diagnosing) that should be addressed in a cycle, addressing the problems identified (planning for action), take part in the action (taking action), and support the decision regarding determining the value of the intervention (evaluation). The focus is on students who completed the subject modules to make recommendations for future offerings.

In addition, it is challenging to find a balanced representation of students to participate in a study such as this one.

Listening to participants may result in hearing conflicting messages, with the preference of each individual heard. Still, hearing the voice of the participant is important in a critical study.

In some instances, participants will make recommendations regarding a focal point, without seeing the full picture. An example of such an occurrence is where a participant indicated that the SMARTguide should include the videos, while it was already included. Also, in some instances, students are not realistic about the academic environment, they indicate that they would like to write more tests, while the experience of the lecturer is that scheduling a test without allocating time to study for it, is of no benefit to the student.

Furthermore, students made suggestions for the use of WhatsApp in addition to being used in preparation for assessment, according to the current situation: explain difficult concepts, make students aware of videos, guide project work, support what happens in class, and post one-question-a-day to be expected in assessments, the list is endless. Accommodating all of these requests are not viable.

When adding the environment to the equation of a study such as this one, it is difficult to build on the success of a previous intervention.

It is the domain of the lecturer to draw on the analysis of data to make informed decisions regarding future developments in the instructional design of the instruction of SA&D, and how the focal points and other technology and non-technology tools should be utilised to support SA&D. In addition, the knowledge gathered from alumni SA&D students, is applied in the context of a new intake of students. It is therefore important for the lecturer to carefully reflect on the implications of the study, to ensure that solid interpretations are considered to be included in the new design for a future implementation.

10.6.4 Recommendations for future work

Throughout the study, the interviews conducted conveyed the message that alumni of SA&D see the value of this intervention. In addition, the perception of the lecturer is that this realisation of its value becomes clearer when graduates enter the job market.

The work done to demonstrate Lessons, highlighted the potential locked up with the eFundi platform, which may be explored in more depth to assist the lecturer in teaching large classes, and students in learning the material and acquiring the skills. Findings from this study indicated that students did not use SMARTguides extensively. The lecturer expects that Lessons may improve students' access to the guide. It is possible to develop a Lessons guide that envelops its associated eFundi subject module tab, which may then guide a student to write a self-assessment or baseline class test, access a resource, obtain and submit an assignment, and/or do a poll. By following the tabs included in Lessons, a student cannot get lost in a sea of information typical of a subject such as SA&D.

The written interviews were encouraging, especially coming from students currently busy with the material, who could see the value of a similar tool. They indicated that Lessons would be an improvement to the SMARTguides. The Lessons demonstration worked especially well since the students participating in the written interviews, were part of the first implementation of the fully implemented AR cycle, with the class already combined in 2019, to address resources from both the former repeating and newcomer classes.

In planning and producing the follow-up PERT video, the powerful impact of Dooyeweerd was experienced first-hand. It helped the lecturer to attempt to stand in the shoes of the student, and reminisce their point of view. The question asked on WhatsApp, following on making this video available to students, emphasised the value of this social tool in the light of what was highlighted during the interviews, where participants relayed that they learn even when they do not participate actively on WhatsApp, they learn from the lecturer and their peers, they value WhatsApp as a learning tool – although they did not realise its potential before doing SA&D.

The journey over the past years with SA&D, and the students, brought a deeper understanding, and much hope for the future. With the demonstration and evaluation done in Chapter 9, new ideas were spawned that may be extended to a fully implemented AR cycle for all SA&D students. The outcome of a full AR cycle intervention will inform subsequent interventions.

10.7 CLOSURE OF THE STUDY

The purpose of this study was to develop guidelines for the use of technology in higher education, based on HCI principles, from a Dooyeweerdian perspective. This purpose has been achieved by investigating extant research on HCI principles, being sensitive to the context of the study, and implementing three AR cycles of intervention in this context. In support of the HCI principles, two frameworks were utilised in guiding the research, namely the framework for TPACK interaction (Mishra & Koehler, 2006), and the AEF (Basden, 2008; Basden, 2018).

The study facilitated the extraction of two sets of guidelines, namely initial guidelines by applying TPACK, and conceptual guidelines by applying AEF. Extraction was facilitated by the three focal points of instructional design (the electronic study guides of SMARTguides and eFundi Lessons), formative guidance (Videos), and summative assessment (WhatsApp groups). The two sets of guidelines were verified and refined by means of two parallel AR cycle interventions, AR Cycle R, to obtain updated guidelines from the initial guidelines, and AR Cycle N, to obtain enhanced guidelines from the conceptual guidelines. Subsequently the two sets of guidelines, namely updated guidelines and enhanced guidelines, formed generalised guidelines, the outcome of this study.

During the parallel AR cycle interventions, participants made valid suggestions to improve the three focal points, and how to improve SA&D. The generalised guidelines were utilised to prepare demonstrations of the three focal points, and to partially implement a new approach in 2019. Participants evaluated the demonstration and partial implementation positively and made suggestions to improve the focal points, to introduce new technology tools that may assist teaching and learning, and to improve the experience of future SA&D students.

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Annexure A: ETHICAL CLEARANCE

TRREE Ethics course certification

TRREE

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Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

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Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2019/03/16
CID : IVPbNa3Pr0

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

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of the TRREE training programme in research ethics evaluation

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South Africa

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2019/03/16
CID : GWRPWZjJlla

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

FMH Continuing Education Program (5 Credits)
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[REV : 20170310]

Annexure B: AUTHORITY FOR SA&D INTERVIEWS AR CYCLE R & N

PhD study: Guidelines for the use of technology in higher education based on human computer interaction principles from a Dooyeweerdian perspective

Participant Name: ______________________________

Age: ____________________

Current status:	working	studying	Other

Dear participant,
The researcher is studying alumni who were enrolled for System Analysis & Design (SA&D) at the North-West University (Vaal Campus).
Although the interview will have an open structure and will therefore allow the opportunity to speak about all areas of the subject experience, the following focal points have been identified:

1. Instructional Design (SA&D I, SA&D II SMARTguides).
2. Formative Guidance (Videos on challenging concepts in both modules of SA&D).
3. Summative Assessment (mobile instant messaging applications, mostly in the form of WhatsApp groups formed to assist students in their preparation for assessments).

You, as participant, is at liberty to stop the interview at any time, or to refrain from answering any questions which you prefer not to answer.

PLEASE TAKE NOTE OF THE FOLLOWING:
If you wish to contact the researcher after the interview, you may do so in any of the following ways:

1. Office: 8-G34
2. Electronic mail: imelda.smit@nwu.ac.za
3. Office telephone number: (016) 910-3294
4. Cellular phone number (WhatsApp): 078 740 8488

Consent Statement
I agree to an interview with the researcher. I am aware that this is a study of SA&D alumni and I have been informed that all information I share is private and confidential. I have been assured of anonymity.

Signature of participant: ______________________________

Thank you,

____
Imelda Smit
Researcher

Annexure C: ACTION RESEARCH CYCLE R – CODE LISTS WITH START AND END TIMES

Participant 1

No.	Code	Start time	End time
01	I used SMARTguide for examination preparation	00:45	01:04
02	I used outcomes (instead of SMARTguide) to ensure all work was covered	00:51	01:59
03	I watched videos selectively	02:03	02:37
04	I also watched YouTube videos	02:21	02:25
05	I used WhatsApp to ask questions	03:14	03:25
06	The WhatsApp group helped me to compare my progress	03:40	04:00
07	SA&D introduced the use of WhatsApp for study purposes	04:43	04:47
08	The WhatsApp group helped me to compare my progress	04:57	05:03
09	Ease of download/installation of SMARTguide to be improved	06:56	07:27
10	Videos were easy to use	08:32	08:45
11	I am comfortable with WhatsApp since I use it every day	09:05	09:13
12	I muted our WhatsApp group when I needed no interruptions	09:25	09:55
13	SMARTguide itself is easy to use	10:14	10:31
14	Ease of download/installation of SMARTguide to be improved	11:11	11:42
15	Videos were easy to download	11:43	11:58
16	The lecturer should restrict the usage of WhatsApp to manage diversions	12:08	13:24
17	Create WhatsApp group early in semester – it is a reminder to prepare for assessments	13:25	13:42
18	Remove students who divert from the group focus – after a warning	13:43	14:04
19	Within WhatsApp I had a variety of communication options	16:13	17:19
20	SA&D made me aware that WhatsApp can be a good tool to support my studies	17:30	17:57
21	WhatsApp allowed me immediate access to information	18:21	18:58
22	Technology tools are all basic with good built-in feedback	20:12	21:29
23	One cannot make mistakes when using the SMARTguide	22:05	22:23
24	One cannot make mistakes when using the videos	22:05	22:23
25	On WhatsApp you can remove yourself by accident, but the lecturer can add you again	22:28	22:52
26	I pinned our WhatsApp group – to prioritise it on the application	23:47	24:18
27	WhatsApp did not allow me to delete a message intended for another recipient but sent on the group	24:21	25:13
28	Lecturer should make students aware of potential mistakes to be made on WhatsApp	26:29	27:04
29	Lecturer should set rules for the use of the WhatsApp group	26:32	26:45
30	The SMARTguide should include more guidance on self-assessment questions	27:22	28:33
31	I used the SMARTguide sequentially – to ensure I cover all material	30:02	30:22

No.	Code	Start time	End time
32	I watched a video more than once – to ensure I understand the concept fully	30:23	31:02
33	I used WhatsApp when I had a question	31:03	32:32
34	It was important to use the tools made available	37:15	38:29
35	An individual may decide which tools (technology and otherwise) to use to achieve a goal	37:15	38:29
36	The three technology tools work perfectly in conjunction with one another	37:15	38:29
37	Improvement – show a video snippet in class to make students aware of its existence	40:04	40:45
38	There was sufficient support for students to access the technology tools	41:16	41:38
39	The three technology tools simulated the teaching environment well	42:01	42:48
40	When I missed a class, the technology tools helped me to catch up	42:21	42:49
41	A video is almost like a lecture, but I can do it in my own time and watch it more than once	43:51	44:41
42	The videos in SA&D motivated me to incorporate (YouTube) videos in my studies	44:22	44:39
43	When I studied alone, the technology tools supported me sufficiently	44:22	44:39
44	The games we played in class motivated me	44:50	45:15
45	The technology tools extended our class	45:36	46:50
46	Three technology tools worked well with other tools	45:58	46:39
47	An individual may decide which tools (technology and otherwise) to use to achieve a goal	45:58	46:49
48	The user determines how the technology tools are used	47:07	47:38
49	The IT course clicked for me in 2nd year	47:38	48:54
50	All challenging concepts were addressed in some form	49:29	50:27

Participant 2

No.	Code	Start time	End time
01	I watched videos extensively	00:35	00:42
02	I used WhatsApp to ask questions	00:35	00:42
03	I used SMARTguide to create my own SMARTguide	00:43	00:59
04	SMARTguide itself is easy to use	02:38	02:52
05	Videos were easy to use	02:38	02:52
06	I am comfortable with WhatsApp since I use it every day	02:38	03:03
07	Make students aware that they can use WhatsApp in collaboration with Google Drive	03:09	06:35
08	I use WhatsApp on my PC through WhatsApp Web or a mobile phone emulator	07:29	08:07
09	I can easily utilise the SMARTguide on my tablet	08:16	08:31
10	I can easily utilise the videos on my tablet	08:16	08:31
11	I use WhatsApp on my PC through WhatsApp Web or a mobile phone emulator	08:46	09:38

No.	Code	Start time	End time
12	Enlist the help of additional administrators to moderate the group	10:36	10:51
13	Remove students who divert from the group focus – after a warning	11:00	11:40
14	The lecturer should restrict the usage of WhatsApp to manage diversions	12:13	12:19
15	Make students aware that they can use WhatsApp in collaboration with Google Drive	14:28	14:55
16	I used SMARTguide to create my own SMARTguide	16:30	16:55
17	One cannot make mistakes when using the SMARTguide	17:29	17:39
18	One cannot make mistakes when using the videos	17:29	17:39
19	WhatsApp did not allow me to delete a message intended for another recipient but sent on the group	17:38	18:01
20	The SMARTguide should include more guidance on what to include in the project documentation	19:15	19:59
21	The SMARTguide should include more guidance on what to include in the project prototype	22:36	23:15
22	Too much information in the SMARTguide may defy the purpose	23:49	24:05
23	Self-made videos are important	24:28	25:02
24	Video drawings may be amended to be clearer using Draw.io	25:34	26:05
25	Multiple WhatsApp conversations were not supported by the quote-feature (➦)	26:31	26:50
26	A WhatsApp group where only the administrator(s) may send message may minimise clutter	26:51	27:17
27	Consider creating two WhatsApp groups, one allowing members to talk and another to post important messages	28:44	29:20
28	A second WhatsApp group allowing informal chats among students may be formed	28:44	29:20
29	The three technology tools work perfectly in conjunction with one another	30:47	30:55
30	Make students aware that they can use WhatsApp in collaboration with Google Drive	30:55	32:20
31	There was sufficient support for students to access the technology tools	33:54	34:34
32	Videos were easy to download	33:54	34:34
33	The three technology tools simulated the teaching environment well	35:05	35:15
34	Make students aware of tools to manage version control	35:05	39:58
35	Balance the level of assistance to students to encourage learning from experience to develop skills	40:27	41:07
36	Improved communication may help students to understand the motivation behind the SA&D teaching approach	41:50	44:14
37	Baseline tests are not working as well as testing what has been taught at the end of a formal class	45:14	45:48
38	All challenging concepts were addressed in some form	47:06	47:45
39	It was important to use the tools made available	47:46	47:50
40	Technology makes our (SA&D) life easier	48:15	49:10
41	SA&D introduced the use of WhatsApp for study purposes	49:12	49:30
42	SA&D made me aware that WhatsApp can be a good tool to support my studies	49:25	50:18

No.	Code	Start time	End time
43	Students should be made aware of available help: on eFundi and WhatsApp	54:31	55:40
44	I used SMARTguide to create my own SMARTguide	56:30	59:10
45	The SMARTguide should include more guidance on what to include in the project prototype	59:20	59:35

Participant 3

No.	Code	Start time	End time
01	I did not watch the videos	00:27	00:35
02	I absorbed information on the WhatsApp groups, but I did not participate	00:51	01:25
03	The WhatsApp groups should encourage deeper discussions	01:26	01:50
04	The WhatsApp groups should encourage deeper discussions	02:30	03:44
05	I am comfortable with WhatsApp since I use it every day	02:30	03:44
06	I used the SMARTguide to obtain the slides	03:45	04:15
07	SMARTguide itself is easy to use	03:45	04:15
08	I did not watch the videos	04:16	04:32
09	Improved communication may help students to understand the motivation behind the SA&D teaching approach	10:39	12:55
10	Relate to students with problems	12:56	15:41
11	I did not watch the videos	26:15	28:25
12	The lecturer should restrict the usage of WhatsApp to manage diversions	31:12	33:19
13	Lecturer should set rules for the use of the WhatsApp group	31:12	33:19
14	Appointment of an assistant to mentor project groups with such a need	33:41	37:05
15	Appointment of an assistant to mentor project groups with such a need	53:55	55:25
16	Appointment of an assistant to mentor project groups with such a need	01:00:40	01:02:16

Participant 4

No.	Code	Start time	End time
01	I used WhatsApp to ask questions	00:28	00:43
02	I watched videos extensively	00:44	01:05
03	I did not find the SMARTguide of much value	01:06	02:10
04	I am comfortable with WhatsApp since I use it every day	03:17	03:26
05	Videos were easy to download	03:27	03:42
06	Videos were easy to use	03:27	03:42
07	Ease of download/installation of SMARTguide to be improved	03:43	04:10

No.	Code	Start time	End time
08	Discord may work well as instant messaging tool since it allows voice conferencing among group members	04:55	07:28
09	I find WhatsApp to be non-intrusive, I can attend to messages when it is convenient for me	07:55	08:52
10	WhatsApp allows discussion among peers	09:25	09:40
11	In WhatsApp, peer-to-peer explanations have much value	09:59	10:50
12	WhatsApp in particular gives feedback in such a way that one can identify a problem	12:31	13:25
13	The SMARTguide should include the videos	14:02	14:10
14	WhatsApp did not allow me to delete a message intended for another recipient but sent on the group	15:51	16:13
15	A SMARTguide that is corrupted or deleted may be downloaded again	16:14	16:23
16	When a video is corrupted or deleted it is easy to download again	16:14	16:23
17	SMARTguide itself is easy to use	16:24	16:40
18	I found the WhatsApp groups to be professional and not cluttered with nonsense	19:56	20:30
19	SA&D introduced the use of WhatsApp for study purposes	20:40	21:01
20	Videos should address more complex issues as well	22:08	22:53
21	The videos afforded me only a basic understanding of challenging concepts	22:08	22:53
22	I would have preferred more complex video topics	22:54	24:35
23	Videos allowed me to learn in a practical way	26:31	27:03
24	The SMARTguide may be more interactive in terms of guidance	27:27	28:31
25	I am comfortable with WhatsApp since I use it every day	29:05	29:30
26	Videos were easy to download	29:31	29:49
27	Ease of download/installation of SMARTguide to be improved	29:50	30:49
28	Videos were easy to use	32:08	32:20
29	I am comfortable with WhatsApp since I use it every day	32:21	32:42
30	I watched videos extensively	33:17	34:13
31	I would have preferred more complex video topics	34:14	34:50
32	A video is almost like a lecture, but I can do it in my own time and watch it more than once	35:08	35:34
33	I would ask questions on a topic after I watched a video	40:35	40:56
34	Technology allows one to share information directly, in a fast and easy way, but in your own time and at your own pace	41:42	42:43
35	I could watch videos at different speeds	42:34	42:44
36	The three technology tools simulated the teaching environment well	43:08	44:16
37	In addition I created my own learning tool (flash cards)	46:34	47:47

Participant 5

No.	Code	Start time	End time
01	Ease of download/installation of SMARTguide to be improved	00:30	00:50
02	The value of the SMARTguide	00:51	01:14
03	SMARTguide itself is easy to use	00:51	01:14
04	I did not watch the videos	01:20	02:04
05	WhatsApp allowed me immediate access to information	02:05	03:19
06	Chances of getting a response on WhatsApp is good	03:20	03:34
07	SA&D introduced the use of WhatsApp for study purposes	03:35	04:25
08	Ease of download/installation of SMARTguide to be improved	05:32	06:40
09	I only used the SMARTguide on eFundi	05:50	06:40
10	I am comfortable with WhatsApp since I use it every day	07:00	07:10
11	I asked friends to ask my questions on WhatsApp	07:11	07:44
12	I absorbed information on the WhatsApp groups, but I did not participate	07:37	08:45
13	I was hesitant to post messages on the WhatsApp group because I feared making a mistake	07:55	08:26
14	I asked friends to ask my questions on WhatsApp	08:27	08:45
15	I would follow up on group conversations with individuals	09:06	09:29
16	I used WhatsApp to ask questions	09:38	10:30
17	In WhatsApp, peer-to-peer explanations have much value	09:38	10:30
18	SA&D introduced the use of WhatsApp for study purposes	10:30	11:30
19	When formalities are removed, we as students learn	12:20	13:07
20	When formalities are removed, we as students learn	13:24	13:45
21	I could ask questions on a topic I still did not understand after class	15:21	16:55
22	The three technology tools simulated the teaching environment well	15:21	16:55
23	The technology tools extended our class	15:21	16:55
24	The SMARTguide is appealing to the eye	18:00	18:18
25	When formalities are removed, we as students learn	18:00	19:55
26	The value of the SMARTguide	18:00	19:55
27	I used WhatsApp to ask questions	22:33	23:00
28	Three technology tools worked well with other tools	35:03	36:40
29	The technology tools extended our class	36:56	37:25
30	I could decide how and what to learn	36:56	37:25
31	The games we played in class motivated me	37:26	38:57
32	The value of the SMARTguide	38:20	38:56
33	An individual may decide which tools (technology and otherwise) to use to achieve a goal	38:57	39:29
34	SMARTguide itself is easy to use	48:50	49:07

35	I am comfortable with WhatsApp since I use it every day	49:08	49:35
36	I muted our WhatsApp group when I needed no interruptions	49:58	50:14
37	On WhatsApp you can remove yourself by accident, but the lecturer can add you again	50:15	50:20
38	One cannot make mistakes when using the SMARTguide	50:21	50:34
39	WhatsApp did not allow me to delete a message intended for another recipient but sent on the group	52:23	54:02
40	I muted our WhatsApp group when I needed no interruptions	54:41	55:49
41	At times the WhatsApp group conversations were overwhelming	54:41	55:49
42	The value of the SMARTguide	56:29	57:00
43	My generation needs competition in teaching and learning – SA&D becomes interesting	01:03:35	01:03:47
44	My generation needs competition in teaching and learning – SA&D becomes interesting	01:04:30	01:04:44
45	The games we played in class motivated me	01:05:47	01:06:15

Annexure D: AEF – FIR TREES

A fir tree presents information visually, and provides an overview of aspectual normativity. Its double-sided bar chart depiction allows for the representation of bad (a challenge) and good (a benefit) – representative of reverberations and functioning, per individual aspect (Basden, 2008:156).

Although an aspectual tree shows both benefits and challenges at a glance, it should be compiled and looked upon with care: (1) understanding of different individuals will vary; for instance the analyst and an interviewed participant may have different perspectives and therefore, further analysis is encouraged, (2) the length of each bar relates to how strong the negativity or positivity regarding an aspect is, but it is not absolute with regard to aspectual functioning, and two bars, representing different aspects, should not be compared according to the bars' length – to conclude that one aspect is better or worse than another, (3) longer bars should be attended to; do they represent major functionings or repercussions, or was too much attention given to them during analysis, and shorter (or zero) bars should also be re-looked to ensure that they were not overlooked during analysis (Basden, 2008:156).

In the application of the fir trees in the aspectual reflection of SMARTguides, the focus is on SMARTguides that are already in use - retrospectively. The qualifying aspects pertaining to the focal points has been identified in Figure 6.1, and the ones that are applicable to the SMARTguides include:

1. The *formative* aspect (EIT). Users who engage with technology (and its interface) in the form of a SMARTguide, have their learning shaped deliberately and in a creative way.
2. The *lingual* aspect (EMC). Engaging with meaningful content implies reading text mainly, although visual material in the form of pictures and videos (*sensitive*) are also incorporated.
3. The *kinematic* aspect (ELI). A SMARTguide is an educational tool which guides its users to engage in life with IS with the purpose to learn new material. The material may be included in the SMARTguide, or a student may be directed to find material in a textbook, an exercise, a video, or in class.

These qualifying aspects have been shown on the aspectual tree (Figure D.1) in bold, with the engagement indicated as superscript.

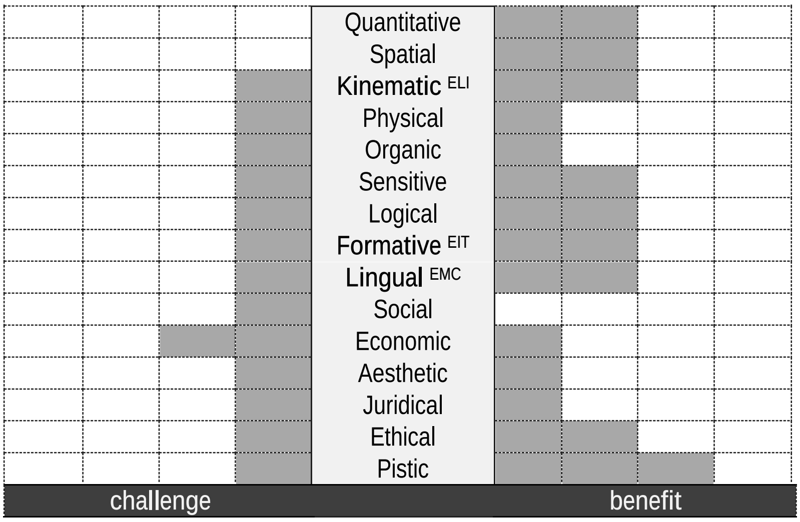

Figure D.1: Fir tree representing SMARTguide repercussions

In the application of the fir trees in the aspectual reflection of videos, the focus is on the videos that are already in use - retrospectively. The qualifying aspects that are applicable to the videos include:

1. The *formative* aspect (EIT). Users who engage with technology (and its interface) in the form of videos, expect to shape their understanding of a particular concept in a deliberate way.
2. The *lingual* aspect (EMC). Engaging with meaningful content implies verbal communication combined with the written word and visual material in the form of pictures (*sensitive*).

3. The *aesthetic* aspect (ELI). Since videos allows us to engage in life with IS involving multiple senses (*sensitive*) with the purpose to harmonise understanding by creating aha-moments.

These qualifying aspects have been shown on the aspectual tree (Figure D.2) in bold, with the engagement indicated as superscript.

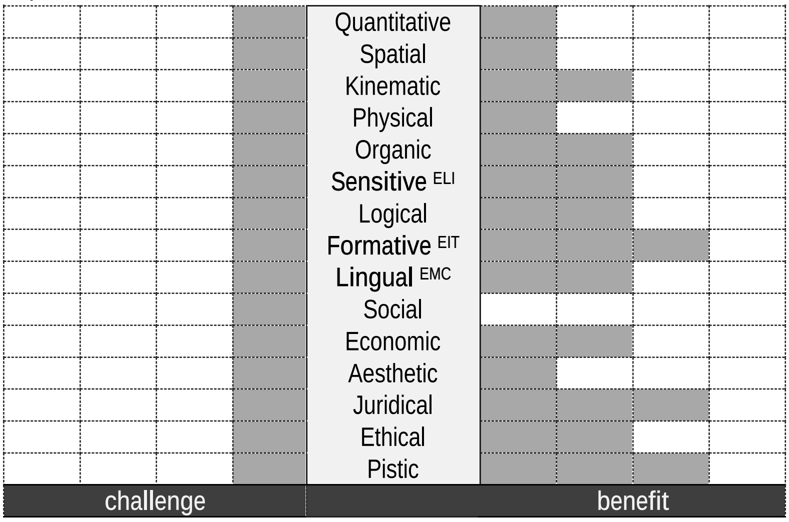

Figure D.2: Fir tree representing repercussions related to the Videos

In the application of the fir trees in the aspectual reflection of the WhatsApp conversations, the focus is on the WhatsApp groups that are already in use - retrospectively. The qualifying aspects that are applicable to the WhatsApp conversations, include:

1. The *economic* aspect (EIT). In this context, engaging with technology (and its interface) implies owning a Smartphone and accessing data. Although both are pre-requisites for joining a WhatsApp group, and thus has monetary implications, it allows direct access to peers.
2. The *lingual* aspect (EMC). Engaging with meaningful content implies communication which is mainly verbal, although voice notes, and visual material in the form of emoji, pictures and videos (*sensitive*) are also utilised.
3. The *social* aspect (ELI). Since WhatsApp allows us to engage in life with IS as a social media mobile application which is used to stay in contact with family and friends. This is not strictly applicable in the educational context, its origin stays the same.

These qualifying aspects have been shown on the aspectual tree (Figure D.3) in bold, with the engagement indicated as superscript.

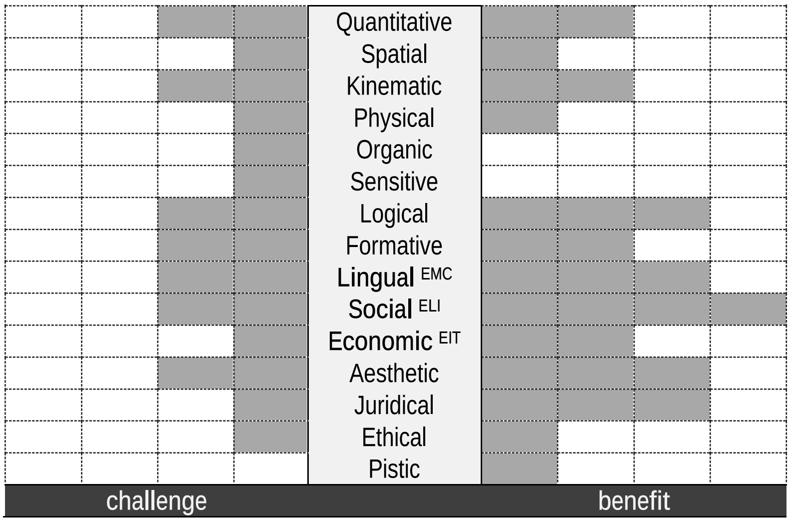

Figure D.3: Fir tree representing repercussions related to the WhatsApp group conversations

Annexure E: ACTION RESEARCH CYCLE N – CODE LISTS WITH START AND END TIMES

Participant 1

No.	Code	Start time	End time
01	I watched videos (selectively) – to learn the concepts	00:38	00:55
02	The WhatsApp group was of much value to me, it kept me informed	00:56	01:05
03	I used the SMARTguide when I prepared for the second examination opportunity	01:06	02:22
Social			
04	WhatsApp was used to allocate jobs to be done for the project	12:30	14:20
05	Sharing of past papers helped us to study	14:25	14:50
06	The SA&D WhatsApp group could sometimes deviate	15:20	16:14
07	I would use the search option to search for the lecturer's messages	16:15	17:56
Sensitive			
08	I was sensitive to some racial inequality topics discussed in our small groups	25:10	28:56
09	When we shared past papers, we also shared answers, which helped	29:02	29:36
10	The lecturer tracked our class work uploads, which motivated us	29:37	32:07
Ethical			
11	WhatsApp groups should be managed when peers get out of hand	34:36	38:00
Formative			
12	I was motivated to work harder when you shared the statistics of SA&D assessments	40:05	44:55
Pistic			
14	Indications from other students regarding their progress on WhatsApp motivated me	48:50	50:07
15	I trusted that the lecturer or a peer would answer my questions	50:08	52:05
Physical			
16	The commitment of my peers energised me	54:13	55:12
17	The fact that peers helped one another motivated me	55:13	56:12
Aesthetic			
18	When discussions flow on the WhatsApp group, we get answers to questions	57:06	57:55
19	The WhatsApp group is a safe place for shy students	57:56	59:46
20	The WhatsApp group was of much value to me, although I did not post messages	57:56	59:46
21	Appropriate jokes relieved stress, while being funny as well	59:47	01:01:40
Lingual			
22	The way people express themselves on WhatsApp, make us feel we belong	01:03:10	01:04:07
Spatial			
23	One can use the WhatsApp group anywhere, anytime	01:05:20	01:07:50

No.	Code	Start time	End time
Economic			
24	Most students will ensure they have WhatsApp access, even with limited funds	01:08:51	01:10:00
25	After hours I would help peers with resources from eFundi, via WhatsApp	01:10:01	01:12:10
Quantitative			
26	Even though our WhatsApp group was big, only a small number of people posted messages	01:13:43	01:14:51
Kinematic			
27	I do not need to do much in terms of movement to converse on WhatsApp	01:16:58:	01:17:34
Organic			
28	Breathing is something that is involuntary	01:17:47	01:18:28
Logical			
29	I need to think logically to be able to answer questions on WhatsApp	01:18:38	01:19:17
Juridical			
30	The WhatsApp group allowed us a platform to obtain answers to questions and share resources	01:20:10	01:22:06

Participant 2

No.	Code	Start time	End time
01	The SMARTguide guided my focus while studying	00:28	00:34
02	I watched videos (selectively) – to learn the concepts	00:35	00:49
03	The WhatsApp group was of much value to me, it kept me informed	00:50	01:20
04	The WhatsApp group was of much value to me, although I did not post messages	00:50	01:20
Economic			
05	Videos were distributed on WhatsApp	02:10	03:00
06	Cannot access eFundi off campus	03:11	04:22
Social			
07	We discussed concepts on WhatsApp	06:30	07:2
Aesthetic			
08	I could load tools on my laptop	08:22	09:09
09	The videos facilitated my understanding	09:10	09:32
10	The videos summarised concepts	09:35	11:22
11	The SMARTguide and videos made studying enjoyable	23:55	24:13
Logical			
12	The SMARTguide directed my focus in SA&D	13:42	15:09
Quantitative			
13	The whole class is accommodated on a WhatsApp group	15:44	16:49

No.	Code	Start time	End time
Spatial			
14	My mobile device helped me to study continuously	16:57	18:20
Kinematic			
15	I could do much when I had my phone in my hand	20:11	20:41
Sensitive			
16	The WhatsApp groups motivated me	23:21	23:35
Juridical			
17	I was listed as the top student on WhatsApp	24:54	25:22
Pistic			
18	We worked together as a group to meet requirements	26:50	28:53
Ethical			
19	SA&D has a lot of information, it puts us under constant pressure	31:04	31:41
20	Assignments should cover two study units, not one	31:56	32:19
Lingual			
21	We communicated in English on all communication forums	33:18	34:04
Formative			
22	I prepared one chapter per day for assessments	34:20	34:47
Organic			
23	Breathing is something that is involuntary	35:46	35:55
Physical			
24	The physical is a given	35:56	36:05
Improvements			
25	The slides should be made available	36:22	37:32
Advice to new students			
26	Keep track of system project progress	38:26	38:44
27	Accomplish weekly project tasks	39:15	39:47

Participant 3

No.	Code	Start time	End time
01	The WhatsApp group was of much value to me, it kept me informed	00:18	00:27
02	The SMARTguide guided my focus while studying	00:28	00:35
03	I watched videos (selectively) – to learn the concepts	00:36	00:50
04	The WhatsApp group was of much value to me, although I did not post messages	00:36	00:50
Social			
05	We also socialised on the WhatsApp group	02:42	03:18
Logical			
06	Videos focuses on what the lecturer wants you to know	03:44	03:57
Juridical			
07	The SMARTguide directed us	04:11	04:29
Formative			
08	The SMARTguide assisted me with my planning	04:32	04:50
Sensitive			
09	Students express their emotions on the WhatsApp group	05:25	05:37
Quantitative			
10	Opinions may be gauged on the WhatsApp group	06:02	06:40
11	We used the class WhatsApp group to create spinoff groups	07:00	07:43
Kinematic			
12	We managed the development of our documentation on Google Docs	07:44	08:30
Pistic			
13	The management of our documentation helped us to see progress	08:58	09:52
14	I made sure I understood what I did wrong in a test	28:25	30:15
15	If you know where you going, you are motivated and focused	32:15	32:48
Lingual			
16	The videos helped me to learn SA&D terminology	10:20	11:14
Economic			
17	Students may use the technology tools instead of attending classes	11:19	12:33
Aesthetic			
18	The classes where we used GLOGs were fun	12:43	15:25
19	I watched videos actively	15:33	17:58
20	Class tests facilitated scaffolding	17:59	20:52
Ethical			
21	Preparing for class helped me to know what to expect	20:58	22:49
22	My group took the challenge of learning according to the guidance provided	22:50	25:37
Spatial			

No.	Code	Start time	End time
23	My mobile device helped me to study continuously	36:08	39:06
Organic			
24	Breathing is something that is involuntary	40:46	40:55
Physical			
25	If you are well rested, you can focus in class	41:02	41:25
26	Working through past papers energised me	42:01	42:32
Improvements			
27	Make more videos, especially difficult theory concepts	46:56	48:10
Advice to new students			
28	Ask if you do not understand – peers and the lecturer	43:57	44:20
29	Group work is key, do your part to learn	44:21	45:00
30	Use tools you learn about in other subjects	45:24	45:51

Participant 4

No.	Code	Start time	End time
01	I had limited use for the SMARTguide	00:36	01:45
02	I did not use the videos	01:46	02:30
03	The WhatsApp group was of much value to me, it kept me informed	02:31	05:00
04	The WhatsApp group was of much value to me, although I did not post messages	02:31	05:00
Physical			
05	The conversation on the WhatsApp group kick-started my learning	08:55	10:15
Social			
06	It was easy to get help from a peer through WhatsApp	10:53	12:27
07	Project group interaction facilitated the development of soft skills	21:38	23:52
08	Group work motivates me to put in more effort	59:58	01:10:00
Sensitive			
09	Emotional reactions on WhatsApp is inappropriate	13:04	15:50
Logical			
10	Logical thinking on the WhatsApp groups is appropriate	17:57	18:31
11	The logical layout of the SMARTguide was helpful	19:08	20:25
Spatial			
12	One can use the WhatsApp group anywhere, anytime	28:32	29:35
13	I could not use the SMARTguide on my phone	29:36	30:32
Lingual			
14	WhatsApp recordings are difficult to multithread	31:05	33:03

No.	Code	Start time	End time
15	The communication variety on WhatsApp assisted discussions	34:12	35:33
Aesthetic			
16	SMARTguide is easy to navigate and it is well-designed	36:37	39:03
17	The WhatsApp facilitated understanding	40:11	41:30
18	The WhatsApp group helped us to share previous exam papers	41:40	42:50
Juridical			
19	The resources available in SA&D assisted deep learning	49:50	59:10
Quantitative			
20	The size of a WhatsApp group determine the dynamics of communication	01:10:42	01:13:00
Formative			
21	SA&D is offered in a structured way, which helps students to cope with the workload	01:13:13	01:16:12
22	Teaching IT subjects should simulate the culture of a work environment	01:16:13	01:17:50
Pistic			
23	The lecturer should provide a clear vision for a subject module	01:18:15	01:18:45
24	Group work needs to be based on trust to perform well	01:19:00	01:21:15
Ethical			
25	Group work relied on going the extra mile	01:22:00	01:24:12
Economic			
26	I was a privileged student in terms of funding	01:24:23	01:25:45
Organic			
27	One needs to be sensitive to stress relief in a stressful job such as IT	01:26:39	01:28:25
Kinematic			
28	One needs to be open to change in our work environment	01:28:50	01:30:10
Improvements			
29	Provide continuous information on what is happening in SA&D	01:30:29	01:36:45
30	Make class work contribute to the participation mark	01:36:46	01:37:51
Advice to new students			
31	Do not listen to other people, and make up your own mind regarding SA&D	01:37:52	01:38:44
32	Do not get overwhelmed initially, give yourself time to make sense of SA&D	01:38:45	01:40:41
33	Work hard on your assignments and use the material in the group project	01:40:42	01:41:31

Participant 5

No.	Code	Start time	End time
01	I watched the videos extensively	00:24	00:32
02	The WhatsApp group was of much value to me, it kept me informed	00:32	00:41
03	I had limited use for the SMARTguide	00:47	01:12
Logical			
04	You need to logically think through a problem in IT	01:49	02:15
05	Verify answers supplied by peers	02:34	02:56
Social			
06	Working with a peer on WhatsApp	04:00	04:18
07	Lights humour before assessments helped for stress release	04:42	05:13
Formative			
08	I made notes that I studied from	05:30	06:04
09	I started the study process with my textbook	06:04	06:35
10	The slides amended the textbook	06:38	07:06
11	I planned well to start early to study for assessment	08:27	09:30
Economic			
12	One needs to plan to use your data bundle frugally	09:51	10:21
Pistic			
13	SA&D allows me to look after myself, have a job	10:56	12:58
13	SA&D may include more agile applications	14:05	15:05
Quantitative			
14	The videos were a great help to me	17:00	17:45
15	Videos on more complex examples may help one to understand	18:40	19:11
16	Videos on OO may support students working in an agile environment	19:15	19:40
Spatial			
17	Work on problems without physically being in class	19:53	20:25
18	The focal points helped me to re-cap what was covered in class	20:30	20:55
19	When missing a class, the tools helped one to catch up	21:10	21:39
Lingual			
20	We communicated in English on all communication forums	21:59	22:50
21	Terminology was easy to learn	22:51	23:42
22	I did additional reading on new concepts	25:50	26:30
Sensitive			
23	Insensitivity on WhatsApp was not a problem	26:52	27:12
24	Knowing there is a WhatsApp group, is good for your morale	27:13	27:29
Physical			

No.	Code	Start time	End time
25	WhatsApp was a backup in terms of answering my questions	27:30	28:10
Kinematic			
26	The focal points were not used (effectively) in other subjects	29:52	30:38
27	Technology requires less effort to get answers to questions	30:50	32:33
28	It is comforting to know I have technology to support me	32:34	32:58
29	I can be helped even at inconvenient times	32:59	33:24
Organic			
30	Breathing is something that is involuntary	33:40	34:03
Aesthetic			
31	SMARTguide is easy to navigate and it is well-designed	34:27	35:17
32	WhatsApp and videos facilitated aha-moments	35:18	36:32
Juridical			
33	Students have access to the devices we need for the focal points	36:51	37:30
34	We had sufficient tools to guide us in SA&D	37:31	38:02
35	There is not a case to be made that we have too much support in SA&D	38:48	39:42
Ethical			
36	The videos were beyond what we needed	39:58	40:35
Improvements			
37	The videos may be expanded	41:00	42:28
Advice to new students			
38	Work hard and you will have success	43:00	44:27
39	Keep a positive outlook	44:28	45:25

Participant 6

No.	Code	Start time	End time
01	The SMARTguide was easy to use	00:25	00:40
02	The WhatsApp group was of much value to me, it kept me informed	00:41	01:43
03	I watched videos (selectively) – to learn the concepts	01:44	02:55
Physical			
04	Making our own videos for class created energy among group members	03:09	03:55
Aesthetic			
05	Making our own videos on SA&D topics were fun	04:06	04:15
06	De-stressing after tests on WhatsApp	04:25	04:42
07	Consultation feedback on our project was constructive	04:43	05:52
08	Videos helped me to explain concepts to peers	06:42	07:10

No.	Code	Start time	End time
09	Explaining concepts to peers made me feel like an expert	07:30	07:50
Sensitive			
10	Using English on WhatsApp showed sensitivity to all	08:24	09:40
11	I needed to use the SA&D group for the purpose it was created	11:57	12:56
Lingual			
12	Home language determined the group formation	15:35	16:26
13	Missing non-verbal communication can cause misunderstanding	29:35	30:24
Ethical			
14	Plagiarism software such as Turnitin directed us to do our own work	20:18	21:05
Pistic			
15	Members in our group did not contribute, but earned marks	25:10	26:21
16	Building trust among peers was supported by the WhatsApp group	32:57	33:05
Social			
17	The WhatsApp group helped to build relationships among peers	31:00	32:05
18	I am a WhatsApp extrovert and an introvert in real life	32:06	32:41
Logical			
19	We researched tools in class which I used in the work place as well	34:33	40:40
20	I listened to videos sub-consciously, repeatedly	41:20	42:07
Formative			
21	I use my textbook in my work environment	42:35	44:50
22	The videos and the textbook complemented one another	44:51	46:50
23	The lecturer needs to communicate why activities are expected	01:16:45	01:17:15
Organic			
24	Initially I did not care for myself, and could not cope with study demands	47:22	55:30
25	Where you stay influence you energy levels, because traveling is exhausting	57:57	58:50
Spatial			
26	The space where one stays impacts your studies	55:52	57:00
27	Participation in group work may be dependent on how far members stay from one another	57:20	57:58
Economic			
28	Not having sufficient funding influence your access to technology devices and data	59:00	01:01:04
Quantitative			
29	Larger numbers of students on WhatsApp groups require more control	01:03:54	01:04:19
30	The larger group sizes allow some students to slack	01:04:20	01:05:47
31	The number of tools allow students to select which ones to use	01:05:54	01:07:40
Kinematic			
32	It is good to hear the perspective from a peer who recently did SA&D	01:08:59	01:10:15

No.	Code	Start time	End time
33	SA&D links with other subject modules in our course	01:10:22	01:11:23
Juridical			
34	The outcomes of the subject directed my learning	01:12:10	01:13:45
35	We received feedback as promised, and you expected us to keep to set dates	01:13:46	01:16:25
Improvements			
36	Soft skills such as facilitation may be supporting our future jobs	01:18:2	01:20:50
Advice to new students			
37	The SA&D content represents skills used in the workplace	01:22:08	01:22:22
38	An analogy representing the SDLC may facilitate the understanding of new SA&D students	01:22:25	01:24:30

Annexure F: WHATSAPP CONVERSATION FOLLOWING THE FOLLOW-UP PERT VIDEO

1. 2019/04/25, 08:58 - [L]: Anybody who knows what the slack on A, C & D is?
2. 2019/04/25, 09:15 - [P1]: I think it is 4
3. 2019/04/25, 09:16 - [P2]: A, D > 2 days || Not sure if I should say C, D or just C but it's 1 day
4. 2019/04/25, 09:16 - [P3]: I think 2 days
5. 2019/04/25, 09:17 - [P4]: No 3 days
6. 2019/04/25, 09:18 - [P4]: A, D 2 days || C, D 1 day
7. 2019/04/25, 09:19 - [P5]: I think || A, D 2 days || A, C 1 day
8. 2019/04/25, 09:20 - [L]: Between A, C, and D 3 days?
9. 2019/04/25, 09:21 - [P6]: I'd say 1
10. 2019/04/25, 09:22 - [P7]: 1 day
11. 2019/04/25, 09:23 - [L]: What do you learn from the lengths of the paths? Regarding slack ...
12. 2019/04/25, 09:24 - [L]: Start with C-D-E.
13. 2019/04/25, 09:25 - [P8]: C-D-E is 1
14. 2019/04/25, 09:26 - [L]: Yes, P8. CP's (B-E) duration is 15 minutes. C-D-E is 14 minutes.
15. 2019/04/25, 09:26 - [L]: So, where will the 1 minute slack be?
16. 2019/04/25, 09:26 - [P8]: C-D
17. 2019/04/25, 09:26 - [P2]: C, D
18. 2019/04/25, 09:26 - [P5]: C,D
19. 2019/04/25, 09:26 - [L]: Which one?
20. 2019/04/25, 09:26 - [L]: Of C and D.
21. 2019/04/25, 09:27 - [L] added P9
22. 2019/04/25, 09:27 - [P8]: This message was deleted
23. 2019/04/25, 09:27 - [P9]: 😁
24. 2019/04/25, 09:27 - [P5]: C.
25. 2019/04/25, 09:28 - [P10]: C
26. 2019/04/25, 09:28 - [L]: Yes, P5.
27. 2019/04/25, 09:28 - [L]: What about D? No slack?
28. 2019/04/25, 09:28 - [P5]: 🕺
29. 2019/04/25, 09:28 - [P8]: Why C.?
30. 2019/04/25, 09:28 - [P2]: There is... It is 2 minutes 🤷‍♂
31. 2019/04/25, 09:28 - [P10]: If C has a slack of 1 minute then D can't have any slack?
32. 2019/04/25, 09:29 - [L]: Good!
33. 2019/04/25, 09:29 - [L]: Can D have 1 minute slack, though?
34. 2019/04/25, 09:29 - [P8]: Mmhh
35. 2019/04/25, 09:30 - [P10]: Why can't D have a slack of 1 and C no slack?
36. 2019/04/25, 09:30 - [L]: They can!
37. 2019/04/25, 09:30 - [P5]: So, D has no slack because 15-14 = 1 and the 1 min goes to C and so,D is left with no slack , right?
38. 2019/04/25, 09:30 - [P10]: Oh🙈
39. 2019/04/25, 09:31 - [P10]: Yes that was my interpretation too!
40. 2019/04/25, 09:31 - [L]: So, when C has 1 min slack, then D has no slack. And
    1. when D has 1 min slack, then C has no slack.

41. 2019/04/25, 09:31 - [P10]: So can we choose any of them? ♂
42. 2019/04/25, 09:31 - [L]: Everybody agrees?
43. 2019/04/25, 09:32 - [P3]: Mam what is the correct answer then for the slack
44. 2019/04/25, 09:32 - [P11]: So they need 1 min of slack between them?
45. 2019/04/25, 09:32 - [L]: We are not done yet!
46. 2019/04/25, 09:32 - [L]: Yes.
47. 2019/04/25, 09:32 - [L]: If this is the case, what of A?
48. 2019/04/25, 09:32 - [L]: Any slack on A?
49. 2019/04/25, 09:33 - [P8]: 2?
50. 2019/04/25, 09:33 - [L]: Partly correct...
51. 2019/04/25, 09:33 - [P2]: So since we say C has 1 minute... Can't we say the slack between A, D is 2?
52. 2019/04/25, 09:33 - [P10]: 1 on A, 1 on D?
53. 2019/04/25, 09:33 - [L]: Ye-e-es
54. 2019/04/25, 09:34 - [P8]: Why 😂
55. 2019/04/25, 09:34 - [L]: And C none?
56. 2019/04/25, 09:34 - [P5]: A is 2 min
57. 2019/04/25, 09:34 - [L]: If A is 2 min, what is D?
58. 2019/04/25, 09:34 - [P8]: You know what I mean
59. 2019/04/25, 09:34 - [P10]: None?
60. 2019/04/25, 09:35 - [L]: Good.
61. 2019/04/25, 09:35 - [P2]: OK
62. 2019/04/25, 09:35 - [P10]: Can we also say this and then C has no slack?
63. 2019/04/25, 09:35 - [P8]: So there can only be 2 between A,B and C.
64. 2019/04/25, 09:35 - [P8]: ?
65. 2019/04/25, 09:35 - [L]: No-o-o
66. 2019/04/25, 09:36 - [L]: So far we have:
67. 2019/04/25, 09:36 - [P8]: Clearly we are not finish 😅
68. 2019/04/25, 09:37 - [L]: If C has 1 min slack, D cannot have slack, and A may have 2 mins slack.
69. 2019/04/25, 09:37 - [L]: Reminder - we do not *have* to use slack...
70. 2019/04/25, 09:37 - [L]: BUT. What happens to A when D has 1 min slack?
71. 2019/04/25, 09:38 - [P8]: It has 1
72. 2019/04/25, 09:38 - [L]: We already said that C has no slack when D has slack.
73. 2019/04/25, 09:38 - [L]: Yes!
74. 2019/04/25, 09:39 - [L]: If D has 1 min slack, C have none, and A also 1 min.
75. 2019/04/25, 09:39 - [P7]: Then the answer is 2 min
76. 2019/04/25, 09:39 - [P8]: I see
77. 2019/04/25, 09:40 - [L]: The answer is:
    👆 If C has 1 min slack, D cannot have slack, and A may have 2 mins slack.
    👆 If D has 1 min slack, C have none, and A also 1 min.
78. 2019/04/25, 09:40 - [P6]: I got it thanx
79. 2019/04/25, 09:40 - [P6]: It's wacky but simple
80. 2019/04/25, 09:41 - [L]: I have another one for you ...
81. 2019/04/25, 09:41 - [L]: Mom's favourite cup is dirty.
82. 2019/04/25, 09:41 - [P10]: Will we have to write down both of them?
83. 2019/04/25, 09:41 - [L]: yes
84. 2019/04/25, 09:42 - [L]: It takes 90 seconds to clean and dry.

85. 2019/04/25, 09:42 - [P2]: So am I wrong if I just say: Between A, D > 2 days || C > 1??
86. 2019/04/25, 09:42 - [L]: Will you be able to finish mom's tea in time?
87. 2019/04/25, 09:42 - [L]: You tell me, P2?
88. 2019/04/25, 09:43 - [P8]: 🙄
89. 2019/04/25, 09:43 - [P6]: Yes there would be max slack of 30sec
90. 2019/04/25, 09:43 - [L]: After cleaning the tea cup, you mean?
91. 2019/04/25, 09:44 - [P8]: <Media omitted>
92. 2019/04/25, 09:44 - [P6]: Yes it can form part of C as getting everything ready
93. 2019/04/25, 09:45 - [P11]: 0_0
94. 2019/04/25, 09:45 - [L]: But C only have 1 min slack, not?
95. 2019/04/25, 09:46 - [L]: And we need 90 seconds...
96. 2019/04/25, 09:46 - [P6]: So won't it form part of C and increase the time then or should a new one be created
97. 2019/04/25, 09:48 - [L]: Keep our real life situation in mind. The problem stated that we are two people making the tea-with sarmie.
98. 2019/04/25, 09:48 - [P6]: Yes so one can clean while the other gets it all together
99. 2019/04/25, 09:49 - [L]: While the kettle boil the water, I am preparing the tray.
100. 2019/04/25, 09:49 - [L]: Dad makes the sarmie - that takes 12 minutes.
101. 2019/04/25, 09:49 - [P5]: Serve 🔥
102. 2019/04/25, 09:50 - [P12]: This is making my life
103. 2019/04/25, 09:50 - [L]: Preparing the tray has 1 min slack. Only.
104. 2019/04/25, 09:50 - [L]: We are so glad, Pieter.
105. 2019/04/25, 09:51 - [L]: The only answer I see, is that our "project" will be late.
106. 2019/04/25, 09:51 - [L]: Do you agree?
107. 2019/04/25, 09:52 - [P10]: Yes || The cup will only be cleaned after 90 seconds.
108. 2019/04/25, 09:52 - [L]: Yes.
109. 2019/04/25, 09:53 - [L]: It may seem silly, since we are talking about 30 seconds in this particular real life scenario. When you are working with projects, we normally work in days.
110. 2019/04/25, 09:53 - [P6]: But if that info was part of the scenario then it would change the chart and also the slack
111. 2019/04/25, 09:54 - [L]: True, P6.
112. 2019/04/25, 09:54 - [L]: In some cases one will pay a penalty for missing the deadline (even one day does miss that deadline!).
113. 2019/04/25, 09:55 - [L]: We plan, and then life happens, and the plan needs to be adjusted.
114. 2019/04/25, 09:55 - [P6]: So this could be added later as an addition to the question once the 1st part is done
115. 2019/04/25, 09:55 - [L]: I wanted you to think about the situation (real life), while answering my questions. You did well.
116. 2019/04/25, 09:56 - [L]: Yes, as a follow-up question.
117. 2019/04/25, 09:56 - [L]: Now you know how to think.
118. 2019/04/25, 09:56 - [P6]: 😎
119. 2019/04/25, 09:57 - [P8]: <Media omitted>
120. 2019/04/25, 09:58 - [L]: Ag shame. I hope she is watching! That will earn brownie points...
121. 2019/04/25, 09:58 - [P8]: 😊
122. 2019/04/25, 10:00 - [P13: <Media omitted>
123. 2019/04/25, 10:01 - [L]: You _will_ be late, yes!
124. 2019/04/25, 10:01 - [L]: Another tip regarding our exercise: The EST & LFT may also guide you. Did you notice that?

Annexure G: AUTHORITY FOR SA&D DEMONSTRATION & EVALUATION

Dear participant,

The researcher is studying students who are enrolled for System Analysis & Design (SA&D) at the North-West University (Vaal Campus).

PhD study: Guidelines for the use of technology in higher education based on human computer interaction principles from a Dooyeweerdian perspective

This demonstration and evaluation focuses on the following focal points:

1. Instructional Design (SA&D I, SA&D II eFundi Lessons).
2. Formative Guidance (Videos on challenging concepts in both modules of SA&D).
3. Summative Assessment (mobile instant messaging applications, currently in the form of WhatsApp groups formed to assist students in their preparation for assessments).

You, as participant, is at liberty to stop your participation in the demonstration and evaluation at any time, or to refrain from answering any questions which you prefer not to answer.

PLEASE TAKE NOTE OF THE FOLLOWING:

If you wish to contact the researcher after the demonstration and completion of the evaluation, you may do so in any of the following ways:

1. Office: 8-G34
2. Electronic mail: imelda.smit@nwu.ac.za
3. Office telephone number: (016) 910-3294
4. Cellular phone number (WhatsApp): 078 740 8488

Consent Statement

By completing the evaluation below, I agree to the researcher using my contribution. I am aware that this is a study of SA&D students and I have been informed that all information I share is private and confidential. I have been assured of anonymity.

Thank you,

Imelda Smit
Researcher

Annexure H: ACTION RESEARCH CYCLE C – CODE LISTS WITH RESPONSES

Lessons

Q1 (a) Would you say that Lessons will work well in the systems analysis and design context? (b) Motivation.		
Code	Yes/No	Written answer
A student may get immediate feedback on issues	Yes	Work is neatly organised, easy to find what you need. Feedback is faster.
Lessons are well organised	Yes	Work is neatly organised, easy to find what you need. Feedback is faster.
Lessons incorporates useful features	Yes	It incorporate all the features that was and is very useful in this course. System analysis and design is a very fast pace busy module and it is very easy to miss or skip something. Hence this new lessons approach will be ideal to have as a student a centralized point where all information and guidelines are stored. Over all it is a really good idea and I definitely approve of it.
A logical step by step approach	Yes	The lessons give a logical or step by step approach to a chapter that will not confuse you.
Lessons are more interactive than the SMARTguide	Yes	Yes. I believe it work well because it is more because, unlike the SMARTGuide, this one is more interactive and students' progress will be easily tracked - so, they are in some way, obligated to use this for their own good.
It is a fresh approach to a module I like	Yes	It will give student a more interactive chance in better understanding the work and mam can also see immediately at where the students struggle the most. It's a fresh approach to the module which i like
Lessons clarify complex concepts	Yes	Lessons make complex concepts to be clearer provided that the setting of the Lessons is conducive for learning.
Students see exactly what to focus on per chapter	Yes	it allows the student to see exactly what they need to focus on per chapter, and to see what is done in class in real time
A student may get immediate feedback on issues	Yes	Yes! This would work well in Systems analysis and Design context as this will be a place of more information, guide and understanding of the module. More contact sessions on both efundi and setting an appointment. What i mean is that more contact on efundi site is that when something comes up and that you don't understand something, you can post a question or your concerns on efundi for the lecturer to give clarity.

Q1 (c) How can the Lessons be improved in the systems analysis and design context? Be specific.	
Code	Written answer
Include past examples to guide what needs to be done	To be a bit more clear in on what should be done where. Maybe some past examples for some guidance.
Guide the fun drag-and-drop test	They can be improved by showing which questions you did not answer correctly on the drag and drop game.
Lessons are a major improvement on what we had	I think that this new implementation of a very interactive eFundi site is a major step taken in improving lessons - this implementation will bring about other changes to the surface.

Q1 (c) How can the Lessons be improved in the systems analysis and design context? Be specific.	
Code	Written answer
Video tutorials on modelling are important	Video tutorials on how to draw diagrams would be a great help because we sometimes understand on how to draw the diagram in class but when we get home to practice we often doubt our choices and where to start for a specific diagram.
Place the emphasis on fun and learning through practice, before class	Doing preparations before class is key to the Lessons being engaging and effective. So emphasis must be put on preparations beforehand. Learning should be fun and we should apply more of real life scenarios that learners can relate to in the Lessons. Everything must be hands on, too much talking and little doing is not effective for learning purposes.
Scenarios must have a print option, to allow students to write down questions	Lessons can be improved by having the students print out the scenarios, this will allow them to write out the correct answer leading to a better study practices, rather than having them stare at a screen the whole time.
All classes should be with the lecturer	The lessons may be improved by having all 4 contact sessions with the lecturer instead of SIs and assistance. The lecturer may share more information, hints and advices with students more than the SIs and assistances. Having all hose contact lessons with the lecturer helps students to be more comfortable with the lecturer and to be able to post questions at that point, rather having an assistant telling a student that they will get back to them and they don't.

PERT video

Q2 (a) Would you say that PERT video will work well in the systems analysis & design context? (b) Motivation.		
Code	Yes/No	Written answer
The video facilitated my understanding	Yes	Videos make it easier to study and understand, you can go through it on your own time. Video work document helps a lot.
A video may be watched over and over, in one's own time	Yes	I gave one an environment where you can go back over and over again to find out what you missed and learn/ grasp the content and chapter in your own time and just not be pressured. Basically taking the lecture home with one’s self.
The break allows one to complete the answer and check it	Yes	You are given a chance to actually do the question before the actual answer is revealed, so this make you to understand and be able to fix your mistakes.
A real-life example of a PERT chart will have more value	No	Well, I don't necessarily think it worked well - for Me personally. I think that maybe a video or an actual practical example of the PERT chart would be more helpful because it is easier to grasp an idea when you actually see its application in the real world rather than just seeing a ''classwork' example/
A video may be watched over and over, in one's own time	Yes	I could follow the video step by step on how to draw the PERT chart and understand it and later on practice it by myself. This helped also at revising for the exam because I could watch the video to just remind myself on how you draw the chart. Served as an extra resource
A video may be watched over and over, in one's own time	Yes	The video was good because slow learners of learners with cognitive challenges are able to refer to it every now and then so as to catch the concepts and be apply to apply them.
- -	Yes	The video was helpful in discussing a difficult/charted question, however it was difficult to find.

Q2 (a) Would you say that PERT video will work well in the systems analysis & design context? (b) Motivation.		
Code	Yes/No	Written answer
The video facilitated my understanding	Yes	Yes! The lecturer goes into detail with the PERT chart and gives more understanding and possible questions that may come up as the lecturer has more intel and knowledge of what may come up in the exams.
A video may be watched over and over, in one's own time	Yes	It explained in the simplest way possible and because it's a video I was able look through it over and over till i was satisfied. and because the video encourages you to do the work and the answer is provided you get to compare what i did t what i should have done making it easier to pin point ones problem area,

Q2 (c) How can the Videos be improved in the systems analysis & design context? Be specific.	
Code	Written answer
Work through more examples	Have more similar questions with memos attached.
Examples on different levels of difficulty	The complexity of the problem and the length of the video being very important.
Examples on different levels of difficulty	Two examples with different difficulty level should be done on the video.
Possible example: plan the construction of Curro	Like I said in the previous answers, a real-life application of things would be better. So, for example, a video that shows how a building contractor would apply the PERT chart in planning the construction of Curro and then brings this idea back home to Systems - how you draw this idea from System Analysts perspective.
The video breakdown helps	A video breakdown in steps would help a lot. Because this way one could first try figuring out the steps understanding them and then watching the video to ensure that your understanding is correct.
Videos should be short	The videos must not be too long and redundancy must be avoided at all times. Some animation in the videos would be nice too. The videos should explain the easiest problem/concept to the most challenging within a scenario that students can relate to.
Group videos in one directory	All videos can be put under a single tab called videos, or if a video is related to a certain chapter have a link within that chapter lead them to the video in the video tab
Lecturers from all campuses should make videos on the same concept	The videos can be improved by having more than 1 video on the same concept. Like for example, having all 3 lecturers across all 3 campuses having to give a video lesson on the Systems analysis and Design context. Some students may understand a lecturer from Potch Campus and one student understanding a lecturer from the Vaal Campus, explaining the same concept. [This is working with another module at this instance].
Ask students questions to determine whether they watched the video	By asking questions specific to the video to determine whether the students watched the video like recommended.

WhatsApp group

Q3 (a) Would you say that WhatsApp group will work well in the systems analysis and design context? (b) Motivation.		
Code	Yes/No	Written answer
Easy to ask questions, get quick responses	Yes	Makes it easier to ask short questions about things that you do not understand. You get quick response, for example at what venue you are writing.
Get help at any moment, from the lecturer, or peers	Yes	One could reach out for help at any given moment, and not only get the lectures input but fellow mates as well problems you couldn't voice had a likelihood of surfacing.
Easily interact with the lecturer, and peers	Yes	You are able to interact with other students and the lecture at any time.
Easily interact with the lecturer, and peers	Yes	It works well for people who are often on whatsapp - it also worked, quite well for Me, because I was often afraid to approach the lecturer in their office for consultation - so it helps on that front of making communication easier.
Examples of how questions may be asked	Yes	It deemed as a direct communication with mam and other students so if we were struggling and not too sure about something we could directly ask for help without a delay. This also gave the students the platform to see what type of possible question there were and the different ways of approaching the different questions
The interaction facilitates understanding	Yes	It works well as we can collaborate within the group to answer certain questions and it is also engaging in a sense that it keeps you on your toes in terms of concepts you are still to understand and figure out.
WhatsApp helped us to learn by listening to peers	Yes	it is said that sometimes another student can explain something better than the teacher, and that is what the whatsapp group was about, it allowed discussions among students to clarify topics and get different viewpoints of the topic
WhatsApp helps us to see how others will answer a question	Yes	Yes! It has worked very well because you get to see how other students and the lecturer may answer it and then, you find that you are helping other students who don't understand that very same thing that you are asking and they were afraid to ask. As students, you get to help each other, electronically.
I learned through the questions of peers	Yes	There were a lot of questions asked and covered in the group that i need assistant with but kept procrastinating when it came to asking for help. So I got to benefit from my peers asking for help.

Q3 (c) How can the WhatsApp groups be improved in the systems analysis and design context? Be specific.	
Code	Written answer
More guidance on project work	Constant updates on what is happening with documentation. A way of sharing examples of what other groups are doing.
- -	I've got no complaints concerning that area.
Use WhatsApp to guide what needs to be completed in class	The lecture should post question that need to be done on that particular day, so that when question are asked we all on the same page.
Get as many students to participate actively	I think. If anything, the MIMA cannot be improved more than it is right now. I think what is important is trying to get, if not all, as many people as possible to participate and be active on the group.
Use WhatsApp to guide that which support what happens in class	It could be more interactive where mam can post video links or submission dates in the group or giving extra resources to the students. Mam could also limit the amount of messages sent on the group by opening responses to messages or types of question that may be asked at a certain time and the closing responses maybe after midnight as people are either studying or sleeping at the time.

Q3 (c) How can the WhatsApp groups be improved in the systems analysis and design context? Be specific.	
Code	Written answer
Use WhatsApp to explain difficult concepts	It should be used to explain the most difficult concepts in an easier way and in an instant way.
A new rule: big files should not be posted if not necessary	The group doesn't really need to be improved; maybe just add a new rule that gifs are not allowed as they waste memory space in students' cell phones. And if you must take a picture of a question ensure that it is clear and visible.
Post one-question-a-day to be expected in assessments	The Mobile Instant Messaging Applications may be improved in the Systems analysis and Design by having a questions a day that may appear in tests and exams. Calling it One-Question-A-Day to improve one student's knowledge one day at a time. Some students deal with a chapter-a-day and this will help students fully master a lot of chapters by that method.
Students should provide answers even if it is wrong	only improvement would have to be on our side as we tend to shy away from asking questions or giving answers when someone asks for help coz were afraid that the answer might be wrong

SA&D

Q4 According to you, is there anything that we may improve in systems analysis and design?	
Code	Written answer
Break down the work for assessments	Getting a better break down for the semester test and exam. Increase the amount of semester tests for participation.
We need to write more semester tests	Getting a better break down for the semester test and exam. Increase the amount of semester tests for participation.
Take students on excursions to IT companies	I have always liked the idea of excursions - so, perhaps -students who are really interested in SA&D and would love to pursue it as a career could be taken out on these if it's not too much admin work.
More elaborate videos on slides, with notes by the lecturer	I have been studying from secondary videos in data structures, and i find that quite helpful. it is basically the lesson that we had gone through but with some side notes from the lecturer.
A breakdown on how papers are marked	The breakdown of instruction on how papers are marked. Maybe an efundi folder that has examples of how certain questions in test and exams are supposed to be answered and with the assignment regarding the documentation Mam can upload an example of how the documentation is supposed to look like
Supply an example of the documentation	The breakdown of instruction on how papers are marked. Maybe an efundi folder that has examples of how certain questions in test and exams are supposed to be answered and with the assignment regarding the documentation Mam can upload an example of how the documentation is supposed to look like
The GhostBuster semester test should contribute	The mock test should have some weight or include a second big test. and every group should present weekly to make sure were actually learning from each other and get penalized for repeating a mistake done by another group.
We need a session to work on our projects	There should be session where we only focus on working on our projects, so that we can help each with difficulties we meet.
Quizzes make classes fun	Thus far I believe that everything is on the right track, especially with the way lessons are conducted. What can be done to improve is to make everything relatable and fun somehow. Quizzes was a cool way of doing that.
Slides should focus on practical work rather than theory	You may also improve the PowerPoint presentation. Let it be more on practical than theory. Yes, theory is equally important but, having to explain the work practically by doing PERT charts and explaining thoroughly, when going through the theory, it will be much easier.

Other technology tools

Q5 Do you have ideas regarding the inclusion of (additional) technology tools that may support student learning in systems analysis and design?	
Code	Written answer
Compile a list of websites to support each study unit	I think that practical websites can be sourced or created that show how to go about mastering each study unit.
Quizzes help us learn terminology and definitions	I think the use of quizzes was a great idea as it helped us see where we lacked and the type of wording used to ask for certain definitions the implementation of that would be great with possible feedback
Make future students aware of Discord	Let students know about Discord. It's a free to use VoIP program that lets people communicate as a group and share documents.
More videos may help us catch what we miss in class	No as yet. But I am for incorporating videos as we miss some of the things that are said in class. So videos on challenging concepts would help a great deal.
Make future students aware of Google Docs	The additional technology tool that may be used is Google Docs (Live).
The technology used should be utilised better by students	With efundi and whatsapp i feel tech needed is already implemented we just need to use it better as students.