

Guidelines for the professional development of
Mathematics teachers in the pedagogical use of
ICT in open distance learning

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Guidelines for the professional development of Mathematics teachers in the pedagogical use of ICT in open distance learning

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Dedication

This thesis is dedicated to my mother, Alida Magrieta Bailey, for her love and devotion and her endless support when I needed it most. Without you this would not have been possible.

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Abstract

Professional development (PD) of teachers is part of the Department of Basic Education's (DBE) initiative to encourage school communities to use of information and communication technology (ICT) to improve the quality of Mathematics teaching and learning. The South African Council of Educators stipulates that PD programmes should align with system-wide needs, strengthen learning area content and outcomes, and promote system transformation. Imbedded in this system-wide criterion is *The White Paper on e-Education* to employ a fully ICT integrated system at all levels of education: management, teaching and learning, and administration by 2013. Mathematics teachers require PD that develops their technological pedagogical and content knowledge (TPACK) and their social professional identity (SPI). The PD of Mathematics teachers for ICT integration can assist the DBE to achieve the aims of *The White Paper on e-Education* and bridge the technology gap between South Africa and international education systems. Open distance learning (ODL) could be a viable method to deliver PD to Mathematics teachers to address their zone of proximal development, develop their TPACK, and establish and maintain their SPI. This study made use of a fully mixed sequential equal status multi-mode research design and methodologies to develop guidelines for the PD of Mathematics teachers in the pedagogical use of ICT in ODL. The qualitative phase (Phase I) was rooted in the interpretivist paradigm. Through an adjustable exploration of a systematic literature review, the researcher identified 23 core documents, analysed them with Atlas.ti™, and conceptualised four themes according to Engeström's third generation activity theory (AT). Phase II (radical exploration phase) of the research design was rooted in the radical structuralist paradigm. In the context of transformation, it developed, validated, and standardised a research instrument for the measurement of Mathematics teachers' PD requirements. The instrument was distributed to 300 senior phase (grades 7-9) Mathematics teachers in eight education management district centres of the WCED. The analyses of the quantitative data conceptualised a fifth activity system. The five activity systems from the adjustable and radical exploration phases were symbiotic, and co-dependent. Expansive learning was used for boundary crossing and network building during six phases of this study. The findings from the six phases of the expansive learning cycle indicated that PD of Mathematics teachers in ODL for Phase III implementation of the e-Education policy should be a joint initiative. Fundamentally ICT integration and implementation should start with Department of Basic Education (DBE) initiatives. The DBE and Provincial Departments of Education (PDEs) should conduct a needs analysis of ICT implementation, evaluate previous ICT PD programmes, plan ICT PD strategies aligned with the ICT development plan, as well as with the requirements of the Mathematics teachers. The DBE and PDE should invest in the provision of ICT equipment, afford human capital, reinstate the laptop initiative for teachers, and supply schools with networked-computer facilities to explore online platforms for PD. Mathematics teachers should assess their professional knowledge to construct new philosophies, create a subject network group, and interact as participants and members within their social environments. The standardised instrument could be used to determine and compare the PD of Mathematics teachers in other provinces and contexts.

Keywords:

- Professional development
- Social professional identity
- Governance
- School environment
- Systematic literature review
- Engeström's activity theory
- Expansive learning
- TPACK
- Zone of proximal development (ZPD)
- Fully mixed sequential equal status multi-mode research design.

Opsomming

Professionele ontwikkeling (PO) van onderwysers vorm 'n integrale deel van die Departement van Basiese Onderwys (DBO) se inisiatief om skoolgemeenskappe te motiveer deur die gebruik van inligting- en kommunikasietegnologie (IKT), asook om die standaard en kwaliteit van Wiskunde-onderwys te bevorder. Die Suid-Afrikaanse Raad van Opvoeders bepaal dat PO programme ontwikkel moet word om die bepaalde behoeftes van die onderwyssisteem aan te spreek, die kritieke uitkomst van die Nasionale Kurrikulum Verklaringbeleidsdokumente te verwesenlik, asook om transformasie in die onderwys te bevorder. Die DBO vereis dat bepalinge van die Witskrif vir e-Opvoedkunde op alle vlakke van bestuur, administrasie en onderwys teen 2013 afgehandel moet word. Om die uitkomst van die e-Opvoedkundewitskrif te verwesenlik, moet Wiskunde-onderwysers PO gebruik om hul tegnologie-, pedagogie- en inhoudskennis (TPACK) te verbreed en hul professionele sosiale identiteit te vestig en te ontwikkel. Hierdie studie het 'n ten volle opeenvolgende, gelyke status multimodale navorsingsontwerp en -metodologie gevolg. Die doel van die studie was om bepaalde riglyne te ontwikkel om oopafstandslere vir die PO van Wiskunde-onderwysers in die gebruik van IKT vir onderrig-leer te ontwikkel. Die kwalitatiewe fase (Fase I) van die navorsing was in die interpretivistiese paradigma gegrond. Fase I (aanpasbare eksplorasiefase) het, deur 'n sistematiese literatuuroorsig, 23 kerndokumente met behulp van Atlas.ti™ geanaliseer. Vier opeenvolgende temas is volgens Engeström se derde generasie aktiwiteitsteorie gekonseptualiseer. Tydens Fase II (radikale ondersoekfase), gegrond in die strukturalistiese paradigma, is 'n vraelys ontwikkel, geldig verklaar en gestandaardiseer om Wiskunde-onderwysers se PO behoeftes te bepaal. Die vraelys is deur 300 Wiskunde onderwysers in agt onderwysdistrikte van die Wes-Kaap voltooi. Die analise van die kwantitatiewe data het 'n vyfde aktiwiteitsisteem gekonseptualiseer. Gesamentlik het die vyf aktiwiteitsisteme netwerke tussen die geïdentifiseerde komponente geskep om uitgebreide leer te bevorder deur die oorstek van grense. Die bevindinge van die ses fases van die uitgebreide leersiklus bevestig die belangrikheid van samewerking tussen alle rolspelers om Wiskunde-onderwysers se PO behoeftes, in besonder ten opsigte van die uitkomst van Fase III van die e-Opvoedingsbeleid, aan te spreek. Die implementering van die proses is die fundamentele verantwoordelikheid van die DBO. Die DBO en die provinsiale departemente moet behoeftebepalinge administreer, voltooide PO programme evalueer, en strategieë ontwikkel om die PO behoeftes van Wiskunde-onderwysers aan te spreek. Wiskunde-onderwysers moet toegang tot IKT, skootrekenaars, en ten volle toegeruste IKT-sentra vir onderrig en leer verkry, asook geleenthede gebied word om in aanlynleeromgewings te eksplloreer. Wiskunde-onderwysers moet aanleer om self te reflekteer, hul konseptuele Wiskundekennis te evalueer, nuwe onderwyflosofieë te ontwikkel, netwerke met ander onderwysers te skep, en aktief deel te neem aan interaksie in hulle sosiale omgewings. Die gestandaardiseerde vraelys kan deur ander navorsers gebruik word om die PO behoeftes van Wiskunde-onderwysers in ander provinsies en omgewings te bepaal en te vergelyk.

Sleutelwoorde: Professionele ontwikkeling; sosiale professionele identiteit; bestuur, skoolomgewing; sistematiese literatuurondersoek; Engeström se aktiwiteitsteorie; uitgebreide leer; TPACK; area van optimale ontwikkeling (ZPD); ten volle opeenvolgende, gelyke status, multimodale navorsingsontwerp.

Solemn Declaration

Certificate of Proofreading and Editing

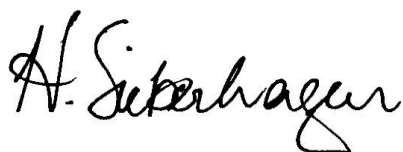
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I hereby declare that I have linguistically edited the dissertation
submitted by ms Verona Leendertz for the PhD degree.

Guidelines for the professional development of Mathematics teachers in
the pedagogical use of ICT in open distance learning



H C Sieberhagen

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Ethics Approval

Table of Contents

Dedication.....	i
Acknowledgements	ii
Abstract	iii
Opsomming	v
Solemn Declaration	vi
Certificate of Proofreading and Editing	vii
Ethical Approval.....	viii
Table of Contents	ix
List of Figure.....	xv
List of Tables	xvii
List of Addenda.....	xix
List of Acronyms and Abbreviations	xxi

Chapter One: Overview of a Research Journey through a Complex Landscape

1.1	Introduction	1
1.2	Motivation and Problem Statement.....	1
1.3	Research Design and Methodology.....	5
1.3.1	Conceptual Framework	7
1.3.1.1	Origin of Cultural–Historical Activity Theory	8
1.3.1.2	Vygotsky’s First Generation Activity Theory	8
1.3.1.3	Rubinshtein’s Psychological-Philosophical Activity Theory	11
1.3.1.4	Leont’ev’s Second Generation Activity Theory	11
1.3.1.5	Engeström’s Third Generation Activity Theory	14
1.3.1.6	Principals of Activity Theory.....	16
1.4	Population and Sample	18
1.5	Ethical Aspects of this Research	18
1.6	Contribution of this Study.....	19
1.6.1	Mathematics Education.....	19
1.6.2	Proposed Research Niche Area: Technology Enhanced Learning for Higher Education (TELHE)	19
1.7	Clarification of Important Terminology for this Study	19
1.8	Summary of the Chapters	21

Chapter Two: Fully Mixed Sequential Status Multi-Mode Design and Methodology: Qualitative Aspects

2.1	Introduction	22
2.2	Worldview of the Research	22
2.2.1	Ontology.....	23

2.2.2	Epistemology.....	23
2.2.3	Research Paradigms	24
2.2.3.1	Phase I: Interpretivist Phase.....	25
2.3	Fully Mixed Sequential Equal Status Multi-Mode Research Design.....	26
2.4	Qualitative Design.....	27
2.4.1	Mixed-method Systematic Literature Review	28
2.4.1.1	Process and Documentation for a Systematic Literature Review.....	31
2.4.1.2	Search Process Documentation	32
2.4.1.3	Selection Process Criteria Documentation	32
2.4.1.4	Quality Assessment of Primary Documents	33
2.5	Data Analysis	34
2.6	Role of the Researcher	40
2.7	Trustworthiness in Qualitative Research	40
2.7.1	Validity in Qualitative Research	40
2.7.2	Reliability in Qualitative Research	41
2.8	Ethical Considerations in Qualitative Research.....	42
2.9	Limitations of the Mixed-method Systematic Literature Review	43
2.10	Summary of the Chapter.....	43

Chapter Three: Culminant Retrospect of a Systematic Literature Probe

3.1	Introduction	44
3.2	Governance.....	44
3.2.1	Theme 1 of Literature Analysis: Governance	46
3.2.1.1	Objects of Governance	46
3.2.1.2	Subject of Governance	48
3.2.1.3	Tools of Governance.....	51
3.2.1.4	Community of Governance	52
3.2.1.5	Rules of Governance	53
3.2.1.6	Division of Labour in Governance.....	54
3.2.2	Governance as Activity System	55
3.3	School Environment.....	56
3.3.1	Theme 2 of Literature Analysis: School Environment.....	57
3.3.1.1	Object of School Environment	58
3.3.1.2	Subject of School Environment.....	60
3.3.1.3	Tools of School Environment.....	61
3.3.1.4	Community of School Environment	64
3.3.1.5	Rules of School Environment.....	65
3.3.1.6	Division of Labour in School Environment.....	65
3.3.2	School Environment as Activity System	65
3.4	Open Distance Learning	67
3.4.1	Theme 3 of Literature Analysis: Open Distance Learning.....	68
3.4.1.1	Objects of Open Distance Learning.....	68

3.4.1.2	Subject of Open Distance Learning	70
3.4.1.3	Tools of Open Distance Learning	71
3.4.1.4	Community of Open Distance Learning.....	72
3.4.1.5	Rules of Open Distance Learning	72
3.4.1.6	Division of labour in Open Distance Learning.....	73
3.4.2	Open Distance Learning as Activity System.....	73
3.5	Professional Development	76
3.5.1	Theme 4 of Literature Analysis: Professional Development.....	76
3.5.1.1	Objects of Professional Development.....	76
3.5.1.2	Subjects of Professional Development	78
3.5.1.3	Tools of Professional Development	81
3.5.1.4	Community of Professional Development.....	82
3.5.1.5	Rules of Professional Development.....	84
3.5.1.6	Division of Labour in Professional Development	84
3.5.2	Professional Development as Activity System.....	88
3.6.	Activity Systems on Two Planes of Cultural-historical Analysis	89
3.6.1	Organisational Plane of Cultural-Historical Analysis	90
3.6.2	Personal Plane of Cultural-Historical Analysis.....	90
3.7	Summary of the Chapter	91

Chapter Four: Fully Mixed Sequential Equal Status Multi-Mode Design and Methodology:

Quantitative Aspects

4.1	Introduction	92
4.2	Worldview of the Research	92
4.2.1	Ontology.....	92
4.2.2	Epistemology.....	92
4.2.3	Research Paradigms	93
4.2.4	Phase II: Radical Structuralist Phase	93
4.3	Fully Mixed Sequential Equal Status Multi-Mode Research Design.....	94
4.4	Quantitative Design.....	94
4.4.1	Quantitative Research Instruments	94
4.5	Planning and Design of a Questionnaire	95
4.5.1	Stage One: Aim of the Questionnaire	96
4.5.2	Stage Two: Select the Questionnaire	96
4.5.3	Stage Three: Linking with of the Research Question	96
4.5.4	Stage Four: Linking with Key Aspects	97
4.5.5	Stage Five: Clarification of Information to Address Key Aspects	97
4.5.6	Stage Six: Determine the Target Population	97
4.5.7	Stage Seven: Compile the Questions and the Metrics	103
4.5.8	Stage Eight: Create the Questionnaire	104
4.5.8.1	Parts A and B: Personal and Demographical Information	104
4.5.8.2	Part C: Governance	105

4.5.8.3	Part D: School Environment.....	106
4.5.8.4	Part E: Information and Communication Technologies	107
4.5.8.5	Part F: Professional Development and Open Distance Learning	108
4.5.8.6	Part G: Professional Development Models	109
4.5.9	Stage Nine: Determine Data Collection Strategy.....	110
4.5.10	Stage Ten: Piloting the Questionnaire	111
4.5.11	Stage Eleven: Prepare for the Data Collection	111
4.5.12	Stage Twelve: Collect the Data.....	112
4.5.13	Stage Thirteen: Data Analysis Phase II	113
4.5.13.1	Descriptive Statistics	113
4.5.13.2	Factor Analysis and Reliability	113
4.5.13.3	Comparisons between Biographical Information and Extracted Factors.....	114
4.5.13.4	Structural Equation Modelling.....	114
4.5.14	Stage Fourteen: Reporting of Findings.....	115
4.6	Role of the Researcher	115
4.7	Credibility in Quantitative Research.....	116
4.7.1	Validity in Quantitative Research	116
4.7.2	Reliability in Quantitative Research	117
4.8	Ethical Considerations in Quantitative Research.....	118
4.9	Limitations of Quantitative Methodology	118
4.10	Summary of the Chapter	119

Chapter Five: Modelling Quantitative Measures and Results

5.1	Introduction	120
5.2	Biographical Information	121
5.2.1	Gender	123
5.2.2	Age.....	123
5.2.3	Years of Teaching Experience.....	123
5.2.4	Years Teaching Mathematics	123
5.2.5	Home Language	124
5.2.6	Language of Instruction	124
5.2.7	Qualification	124
5.2.8	Subject Specialisation	124
5.2.9	School Districts	125
5.2.10	School Quintiles	125
5.2.11	Type of School	125
5.2.12	Number of Learners	125
5.2.13	Number of Computer Laboratories	125
5.2.14	Overall Computer Available	127
5.2.15	Computers with Internet Access	127
5.2.16	Computer Literacy Level	128
5.2.17	Personal Computers	128

5.2.18	Access to the Internet	129
5.2.19	Interactive Whiteboards	129
5.2.20	Online Courses	129
5.2.21	Utilisation of Information and Communication Tools	129
5.2.22	Professional Development Models	130
5.3	Factor Analysis	131
5.3.1	Reliability of the Factors.....	131
5.3.2	Results of Factor Analysis of Governance.....	131
5.3.3	Factor Analysis of School Environment	133
5.3.4	Factor Analysis of Information and Communication Technologies.....	135
5.3.5	Factor Analysis of Professional Development	136
5.3.6	Factors Conceptualised as Elements of Activity Theory	138
5.4	Comparisons between Biographical Information and the Elements of the Triangular Activity System	139
5.4.1	Descriptive statistics on Elements of Triangular Activity System and Results of Hierarchical Linear Modelling	140
5.4.1.1	Descriptive Statistics on Elements of Triangular Activity System and the Results of the Hierarchical Linear Modelling, Effect Sizes and Gender Differences	140
5.4.1.2	Descriptive Statistics on Elements of Triangular Activity System and the results of the Hierarchical Linear Modelling, Effect Sizes and Home Language Differences	142
5.4.1.3	Descriptive Statistics on Elements of Triangular Activity System and the Results of the Hierarchical Linear Modelling, Effect Sizes and Language of Instruction Differences	144
5.4.1.4	Descriptive Statistics on Elements of Triangular Activity System and the Results of the Hierarchical Linear Modelling, Effect Sizes and Qualification Differences	146
5.4.1.5	Descriptive Statistics on Elements of Triangular Activity System and the Results of the Hierarchical Linear Modelling, Effect Sizes and Subject Specialisation Differences.....	149
5.4.1.6	Descriptive Statistics on Elements of Triangular Activity System and the Results of the Hierarchical Linear Modelling, Effect Sizes and Education District Differences	149
5.4.1.7	Descriptive Statistics on Elements of Triangular Activity System and the Results of the Hierarchical Linear Modelling, Effect Sizes and Quintile Differences.....	150
5.4.1.8	Descriptive Statistics on Elements of Triangular Activity System and the Results of the Hierarchical Linear Modelling, Effect Sizes and Type of School Differences	153
5.4.2	Elements of Triangular Activity System and Results of Hierarchical Linear Modelling.....	157
5.5	Summary of the Chapter	159

Chapter Six: Mapping Guidelines for the Professional Development of Mathematics Teachers in the Pedagogical Use of Information and Communication Technologies in Open Distance Learning

6.1	Introduction	160
6.2	Summary of Chapters	160
6.2.1	Chapter One: Overview of a Research Journey through a Complex Landscape.....	160

6.2.2	Chapter Two: Fully Mixed Sequential Status Multi-Mode Design and Methodology: Qualitative Aspects	161
6.2.3	Chapter Three: Culminant Retrospect of a Systematic Literature Probe	161
6.2.4	Chapter Four: Fully Mixed Sequential Status Multi-Mode Design and Methodology: Quantitative Aspects	162
6.2.5	Chapter Five: Modelling Quantitative Measurements and Results.....	163
6.3	Synopsis of the Adjustable and Radical Exploration Phases of the Research.....	163
6.3.1	Synopsis of the Findings of the Adjustable Exploration Phase of the Research.....	163
6.3.2	Synopsis of the Findings of the Radical Exploration Phase of the Research.....	165
6.4	Validation of the Adjustable and Radical Exploration Phases through Structural Equation Modelling	166
6.4.1	Structural Equation Modelling of Governance, School Environment and Open Distance Learning	166
6.4.2	Structural Equation Modelling of Mediation of Governance, School Environment, Open Distance Learning and Professional Development.....	168
6.4.3	Structural Equation Modelling of Expansive Learning of Governance, School Environment, Open Distance Learning and Professional Development	169
6.4.4	Five Activity Systems from the Adjustable and Radical Exploration Phases of the Research Connected Through Boundary Objects.....	171
6.4.5	Expansive Learning through Boundary Crossing in the Five Activity Systems	172
6.5	Guidelines for the Professional Development of Mathematics Teachers in the Pedagogical Use of Information and Communication Technology in Open Distance Learning.....	174
6.6	Future Research	178
6.7	Value of the Research	179
6.8	The Researcher's Reflections of the Research Journey	179
6.8.1	Fully Mixed Sequential Equal Status Multi-Mode Research Design and Methodology ...	179
6.8.2	Engeström's Activity Theory	180
6.8.3	Systematic Literature Review	180
6.8.4	Data Collection Journey.....	181
	Bibliography.....	182

List of Figures

Figure 1.1	Choosing a Multi-Mode Research Design according to the Four Paradigms of Social Theory	6
Figure 1.2	Vygotsky's First Generation CHAT	9
Figure 1.3	Leont'ev's Second Generation Activity Theory	12
Figure 1.4	Hierarchical Model of Human Activity	13
Figure 1.5	Engeström's Third Generation Activity Theory	15
Figure 1.6	Two Dimensions for this Multi-Mode Research Design	17
Figure 2.1	Phases of the complex research according to the four paradigms	24
Figure 2.2	Fully Mixed Sequential Equal Status Multi-mode Design	30
Figure 2.3	Mixed-method Systematic Review Flow Diagram of Document Selection Process	34
Figure 2.4	Atlas.ti™ Workflow	36
Figure 2.5	Structure and Code Density of the Guidelines for the Professional Development of Mathematics Teachers in the Pedagogical use of ICT in ODL	39
Figure 3.1	Network views of the Four Overarching Themes from the Inductive Analysis	45
Figure 3.2	Governance as a Theme from the Literature Analysis	46
Figure 3.3	Governance Activity System	56
Figure 3.4	Mediated Relationship between the Subject and Object, and Interrelations among the Elements of Governance Activity System	57
Figure 3.5	School Environment as Theme from Literature Analysis	58
Figure 3.6	School Environment as Activity System	66
Figure 3.7	Mediated Relationship between the Subject and Object, and Interrelations among the Elements of School Environment Activity System	67
Figure 3.8	Open Distance Learning as Theme from Literature Analysis	68
Figure 3.9	Open Distance Learning Activity System	74
Figure 3.10	Mediated Relationship between the Subject and Object, and Interrelations among the Elements of Open and Distance Learning Activity System	75
Figure 3.11	Professional Development as Theme from Literature Analysis	77
Figure 3.12	Professional Development Activity System	88
Figure 3.13	Mediated Relationship between the Subject and Object, and Interrelations among the Elements of Professional Development Activity System	89
Figure 3.14	Four Conceptual Activity Systems on Two Planes of Cultural-Historical Analysis	91
Figure 4.1	Geographical Locations of the Districts in Western Cape Province	99
Figure 4.2	Group Session in the West Coast EMDC	110
Figure 4.3	Group Session in the Metro South EMDC	111
Figure 5.1	Computer Laboratory Bolted with a Metal Door	126
Figure 5.2	Khanya Laboratory with Computers under Workstations	126
Figure 5.3	Computers for Planning and Administration	127
Figure 5.4	Triangular Activity System	138

Figure 6.1	Structural Equation Model of Governance, School Environment, Open Distance Learning, and Professional Development with Standardised Regression Weights ...	167
Figure 6.2	Structural Equation Model of Mediation of Governance, School Environment, Open Distance Learning, and Professional Development with Standardised Regression Weights	169
Figure 6.3	Structural Equation Model of Expansive Learning from Governance, School Environment, Open Distance Learning, and Professional Development with Standardised Regression Weights	170
Figure 6.4	Conceptual and Triangular Activity Systems	172
Figure 6.5	Expansive Learning Cycle for Guidelines for the Professional of Mathematics Teachers in the Pedagogical use of ICT in ODL	173

List of Tables

Table 2.1	Ontological and Epistemological Assumptions of the Interpretivist Paradigm.....	25
Table 2.2	Six Key Steps in Conducting a Systematic Literature Review.....	31
Table 2.3	Terminology and Functions of Atlas.ti™	35
Table 2.4	Pattern Matrix of Factors.....	37
Table 2.5	Strategies for Validity of the Document Analysis	41
Table 2.6	Strategies for Reliability of Document Analysis	42
Table 3.1	Western Cape Education Department ICT Readiness	47
Table 3.2	Requirements for ICT Integration at National, Provincial and School Level.....	54
Table 3.3	Professional Development Models and Frameworks	86
Table 4.1	Ontological and Epistemological Assumptions of the Structuralist Paradigm	93
Table 4.2	Stages in Sample Selection	98
Table 4.3	Site Location of the Nine Education Districts in the WCED	99
Table 4.4	Participating Schools in the Eight Educational Districts	101
Table 4.5	Types of Participating Schools	101
Table 4.6	Quintiles of Participating Schools	102
Table 4.7	Medium of Instruction of Participating Schools.....	102
Table 4.8	Number of Schools and Participants	102
Table 4.9	Seven Guidelines to Formulate Questions	104
Table 4.10	Comprehensive Description of Compilation of Questions for Governance	105
Table 4.11	Comprehensive Description of Compilation of Questions for School Environment ..	106
Table 4.12	Comprehensive Description of Compilation of Questions for Information and Communication Technologies	107
Table 4.13	Comprehensive Description of Compilation of Questions for Professional Development.....	108
Table 4.14	Fourteen Stages in Questionnaire Development.....	115
Table 5.1	Frequencies and Percentages of Part A and Part B of the Questionnaire	121
Table 5.2	General Use of ICT Tools	129
Table 5.3	ICT Tools for School Use.....	130
Table 5.4	Frequencies and Percentages of Professional Development Models	130
Table 5.5	Factor Analysis of Governance.....	132
Table 5.6	Factor Analysis of School Environment	134
Table 5.7	Factor Analysis of Information and Communication Technologies	135
Table 5.8	Factor Analysis of Professional Development	136
Table 5.9	Professional Development of Mathematics teachers in the pedagogical use of ICT in ODL According to the Triangular Activity System.....	139
Table 5.10	Descriptive statistics on Elements of Triangular Activity System and Results of Hierarchical Linear Modelling and Effect Sizes to Test for Gender Differences	141
Table 5.11	Descriptive Statistics on Elements Triangular Activity System and Results of Hierarchical Linear Modelling and Effect Sizes for Home Language	143

Table 5.12	Descriptive statistics on Elements of Triangular Activity Theory and Results of Hierarchical Linear Modelling and Effect Sizes for Language of Instruction Differences.....	145
Table 5.13	Descriptive statistics on Elements of Triangular Activity System and Results of Hierarchical Linear Modelling for Qualification	147
Table 5.14	Effect Sizes to Test for Qualification Differences	148
Table 5.15	Descriptive statistics on Elements of Triangular Activity System and Results of Hierarchical Linear Modelling for Quintiles Differences.....	151
Table 5.16	Effect Sizes for Quintiles.....	152
Table 5.17	Descriptive statistics on Elements of the Triangular Activity System and the Results of Hierarchical Linear Modelling for Type of School	154
Table 5.18	Effect Sizes for Type of School.....	155
Table 5.19	Hierarchical Linear Modelling for Biographical Information	158
Table 6.1	Standardised Regression Weights and Correlations between Governance, School Environment and Open Distance Learning.....	166
Table 6.2	Standardised Regression Weights and Correlations of Mediation between Governance, School Environment, Open Distance Learning.....	168
Table 6.3	Standardised Regression Weights and Correlations of Expansive Learning from Governance, School Environment, Open Distance Learning and Professional Development.....	170
Table 6.4	Guidelines for the Professional Development of Mathematics Teachers in the Pedagogical Use of ICT in ODL.....	174
Table 6.5	Pertinent Future Research Questions	178

List of Addenda

Addendum 1.1	Publish Notification of Article to Pythagorus
Addendum 2.1	Diary of Systematic Review Search Process
Addendum 2.2	First Selection of Documents during the Systematic Review Process
Addendum 2.3	Documents Screened for Inclusion and Exclusion for Qualitative Analysis
Addendum 2.4	Documents Included for Qualitative Analyses
Addendum 2.5	Calculation of Cohen's Kappa
Addendum 2.6	Documents Selected for Peer Coding
Addendum 2.7	Output Values of Constant Comparative Analysis
Addendum 2.8	Factor Analysis of the Qualitative Data
Addendum 2.9	Atlas.ti™ Workflow of Qualitative Data Analysis
Addendum 3.1	Presentation for Edmedia Conference 2013
Addendum 4.1	Western Cape Education Department Organogram
Addendum 4.2	Letter to Superintendent-General of the Western Cape Education Department
Addendum 4.3	Education Management Information System Database List of Schools in the Western Cape Education Department
Addendum 4.4	Output of Questionnaire Data Captured with Epidata Software
Addendum 4.5	Stratified Sample of Schools Selected for Data Collection
Addendum 4.6	Frequency Tables of Schools Selected through a Stratified Sample Selection
Addendum 4.7	Cover Letter of the Cross-Sectional Questionnaire
Addendum 4.8	Basic Instructions to Complete the Cross-Sectional Questionnaire
Addendum 4.9	Validation of the Questionnaire with Mathematics Lecturers at the Potchefstroom Campus of the North-West University
Addendum 4.10	Validation of the Questionnaire with Mathematics Teachers in the North-West Province
Addendum 4.11	Cross-Sectional Questionnaire Distributed to Senior Phase (grades 7-9) Mathematics Teacher in the Western Cape Education Department
Addendum 4.12	Data Collection Schedule
Addendum 4.13	Ethic Approval of Project from the Potchefstroom Campus of the North-West University
Addendum 4.14	Research Approval from the Western Cape Education Department
Addendum 4.15	Reflection of Quantitative Data Collection
Addendum 4.16	Permission Letter to Schools to Distribute the Questionnaire
Addendum 4.17	Permission Letter to Curriculum Advisors to Distribute the Questionnaire
Addendum 4.18	Permission Letter to Senior Phase (grades 7-9) Mathematics Teachers to Complete the Questionnaire
Addendum 4.19	Turnitin Report of Chapter One
Addendum 4.20	Turnitin Report of Chapter Two
Addendum 4.21	Turnitin Report of Chapter Three
Addendum 4.22	Turnitin Report of Chapter Four

Addendum 4.23	Turnitin Report of Chapter Five
Addendum 4.24	Turitin Report of Chapter Six
Addendum 5.1	Descriptive Statistics of the Biographical Information of the Questionnaire (Part 1)
Addendum 5.2	Descriptive Statistics of the Biographical Information of the Questionnaire (Part 2)
Addendum 5.3	Pattern Matrix of Factor Analysis of Parts C, D, E, and F of Questionnaire
Addendum 5.4	Cronbach's Alpha Calculation for Reliability of Factor Analysis
Addendum 5.5	Hierarchical Linear Models with Statistical Programme for Social Science: Biographical Information and the Elements of Triangular Activity System
Addendum 5.6	Hierarchical Linear Models with SAS: Biographical Information (Parts A2, A3 and A4) and the Elements of Triangular Activity System
Addendum 5.7	Hierarchical Linear Models with SAS: Biographical Information (Parts B11, B13 and B14) and the Elements of Triangular Activity System
Addendum 5.8	Hierarchical Linear Models with SAS: Biographical Information (Parts B6 and B11) and the Elements of Triangular Activity System
Addendum 6.1	Structural Equation Modelling

The addenda are available on a CD-ROM at the back of the thesis.

List of Acronyms and Abbreviations

ACE	Advanced Certificate in Education
ANA	Annual National Assessment
AT	Activity Theory
BA	Bachelor of Arts
BEd	Bachelor in Education
BSc	Bachelor in Sciences
CA	Curriculum Advisor
CAS	Conceptual Activity System
CAQDAS	Computer Assisted Qualitative Data Analysis System
CFI	Comparative Fit Index
CHAT	Cultural Historical Activity Theory
CHET	Council of Higher Education and Training
CK	Content Knowledge
CMC	Computer Mediated Communication
COP	Community of Practice
CPTD	Continuous Professional Teacher Development
DBE	Department of Basic Education
DE	Distance Education
DHET	Department of Higher Education and Training
DL	Distance Learning
EMDC	Education Management District Centre
EMIS	Education Management Information System
FIT	Fluent with Technology
FITness	Fluency of Information Technology
GPS	Global Position System
GSP	Geometer's Sketchpad
HDE	Higher Diploma in Education
HEI	Higher Education Institutes
HEQF	Higher Education Qualifications Framework
HOD	Head of Department
ICT	Information and Communication Technologies
IEA	International Association for the Evaluation of Educational Achievement
IMG	Institutional Management and Governance planning
ITE	Initial Teacher Education
KMO	Kaiser-Meyer-Olkin measure
LMS	Learner Management System
LTA	Learning Technology Advisor
MEd	Master in Education
NCS	National Curriculum Statement

NDoE	National Department of Education
NEPAD	New Partnership for Africa's Development
NQF	National Qualifications Framework
NWU	North-West University
OBE	Outcome-based Education
ODL	Open Distance Learning
OL	Open Learning
PCK	Pedagogical Content Knowledge
PD	Professional Development
PDE	Provincial Department of Education
PIAC on ISAD	Presidential International Advisory Council on Information Society and Development
PLE	Personal Learning Environments
RMSEA	Root Mean Square Error of Approximation
SACMEQ	Southern and East Africa Consortium for Monitoring Education Quality
SAIDE	South African Institute for Distance Education
SAQA	South African Qualifications Authority
SE	School Environment
SEM	Structural Equation Modelling
SETA	Skills Education and Training Authorities
SITES 2006	Second International Information Technology in Education Study
SMT	School Management Team
SNE	Special Needs Education
SPD	Social Professional Development
SPI	Social Professional Identity
SPSS	Statistical Programme for Social Sciences
TAS	Triangular Activity System
TELHE	Technology Enhanced Learning for Higher Education
TIMMS	Trends in International Mathematics and Science Study
TK	Technological Knowledge
TPACK	Technological Pedagogical and Content Knowledge
TPD	Teacher Professional Development
UODL	Unit for Open Distance Learning
VLE	Virtual Learning Environments
VPN	Virtual Private Network
WCED	Western Cape Education Department
ZPD	Zone of Proximal Development