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

Verona Leendertz

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Verona Leendertz

Student number 13173391

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Promoter: Prof Dr A Seugnet Blignaut

Co-promoters Dr Suria Ellis

Prof Dr Hercules D Nieuwoudt

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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 uitkomste van die Nasionale Kurrikulum Verklaringbeleidsdokumente te verwesenlik, asook om transformasie in die onderwys te bevorder. Die DBO vereis dat bepalings van die Witskrif vir e-Opvoedkunde op alle vlakke van bestuur, administrasie en onderwys teen 2013 afgehandel moet word. Om die uitkomste 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 oopafstandsleer 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 oorsteek 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 uitkomste 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 behoeftebepalings 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 eksploreer. Wiskunde-onderwysers moet aanleer om self te reflekteer, hul konseptuele Wiskundekennis te evalueer, nuwe onderwysfilosofieë 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

H C Sieberhagen	**Translator and Editor**
SATI no 1001489	**082 3359846**

CERTIFICATE ISSUED ON 10 OCTOBER 2013

I hereby declare that I have linguistically edited the dissertation

submitted by ms Verona Leendertz for the PhD degree.

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H C Sieberhagen

SATI number **1001489**

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Ethics Approval

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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-Olkim 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