The integration of information and communication technologies into teaching of physical science in Lesotho

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Dissertation submitted in fulfilment of the requirements

for the degree

Magister Educationis

in the

School of Mathematics, Natural Sciences and Technology Education

Faculty of Education

University of the Free State

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January 2017

Declaration

I hereby declare that the work submitted here is the result of my own investigations and that all the sources I have used or quoted have been acknowledged by means of complete references. I further declare that the work is submitted for the first time at this university towards a Master's in Education and it has never been submitted to any other university in order to obtain a degree.

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Dedication

To my late mother

Mateboho Valeria Lisene

for her inspiration and encouragement.

Acknowledgements

I wish to express my gratitude to the following:

- The office of the SANRAL Chair in Mathematics, Natural Sciences and Technology Education and the Research Directorate at the University of the Free State for financial support and guidance.
- Professor L.C. Jita, my main supervisor, for guiding me with patience and understanding.
- Dr T. Jita, my co-supervisor, for reading through my drafts and providing valuable feedback and comments.
- Professor R. Schall and Doctors M. Tsakeni, L. Sibanda and S. Mosia for their contribution to this study.
- Ms. E. Verster who was my professional editor for helping and guiding me with patience throughout the study.
- Ms. B. Wilcock, the editor in the SANRAL Chair's office for reading and editing sections of this document at various points in time.
- My entire close-knit and extended family for their love and support.
- Ms. M.C. Moeketsi and all my other friends for being there for me and always encouraging me to never give up.
- My principal, Mrs M. Mahase, for her understanding and always allowing me some time off to work on my study.
- All the teachers who welcomed me with open hearts and provided the information that I needed to complete my study.
- Almighty God, our Lord for granting me life, strength and protection.

Summary of the study

The integration of information and communication technologies into teaching of physical science in Lesotho

Change is anon-goingprocess that is affected by the person's capabilities and emotions associatedwith the innovation. The knowledge of information and communication technologies (ICTs) for teaching has recently become increasingly important because of the impact of ICTs on our daily lives. However, many teachers worldwide do not take full advantage of the potential brought by the availability of modern technologies in their daily professional activities.The proposed change to the high school physical science curriculum – the integration of (ICTs) into the subject – is thus likely to depend on teachers' feelings and abilities. As a result, the researcher examined the practices of the teachers in terms of the ICT resources they may be using and the manner in which they may be using them. The researcher also aimed to answer the question of the type of knowledge the teachers apply in their use and/or integration of ICTs as well as the types of concerns they may be experiencing during the implementation of the ICT-based physical science curriculum. Therefore, the aim of the present studywas to explore the practices, knowledge and concerns of physical science teachers regarding the integration of ICTs into the curriculum in selected Lesotho high schools.

As the study is organised into two articles,one of the theoretical frameworks underpinning thefirst article is constructivismbecause this theory emphasises the involvement of the learners in their own learning and so does teaching with ICTs. The other framework that guided the researcher in article 1 is the technological pedagogical content knowledge (TPACK) lens, which is widely employed by researchers to assessteachers' preparedness to teach efficiently with ICTs. The concerns-based adoption model (CBAM) was utilised for the second article to examine the teachers' beliefs and aptitudes that manifest as concerns because they are capable of influencing the implementation of the integration of ICTs into teaching.

Data were collected from a random cluster sample of 23 schools using a questionnaire based on theCBAM stages of concern questionnaire (SoCQ) and the TPACK survey instrument. The statistical analysis software (SAS) was employed to

analyse the quantitative data obtained to get the descriptive results and the ANOVA on the two null hypotheses.

The first article addresses the teachers’ practices and knowledge. The first set of results discussed in article 1 reveals that 77% of the teachers used ICT resources such as mobile phones, computers and the Internet for teaching while 80% used them outside the classroom. This demonstrates that many teachers used ICTs even though they used them more for other professional activities than for teaching. The study therefore, concludes that Lesotho teachers integrate ICTs into their teaching of physical science. Nonetheless, the physical science teachers need to be supported in a variety of ways in order to increase the percentages of teachers who use and integrate ICTs from 70 and 80 as well as widen their knowledge to the entire array of ICTs to which they have access.

The second set of results from article 2 reveal that the teachers’ TPACK mean score was 2.88 and this score was below the average of 3.0 for the Likert points of the items on teachers’ TPACK, which falls on moderate knowledge. This score demonstrates a lower perception of TPACK, which means a lack of understanding of the integration of technology into pedagogy and content.This implies that the teachers may not have the necessary skills for effective integration of ICTs into teaching even though they attempt to integrate them. The mean for PCK was the highest at 3.89.This is indicative of the teachers’ ability to integrate pedagogy into content successfully. Consequently, there is a need to increase the in-service support to teachers for successful integration of technological knowledge into the curriculum in high schools in the kingdom of Lesotho in terms of maximising the use and integration of a variety of technologies.

Article 2 considered the teachers’ concerns regarding the integration of ICTs into their teaching. The results examined in article 2 indicate that the most intense concerns are the informational self-concerns with the highestpercentile scoreat 87.5. This implies that most of the teachers had strong stage 1 concerns hence they wanted to find out more information about ICT integration. However, most of the probability values were above the maximum level risk value,$\alpha = 0.05$, which indicates that there were no significant differences in knowledge and concerns between the

various groups of teachers. The researcher thus concluded that the physical science teachers in Lesotho mostly have informational concerns, regardless of their age, gender, type or location of school and years of teaching experience. Most teachers also have enough pedagogical content knowledge even though they lack technological pedagogical content knowledge. Consequently, the main recommendation of this study is for the in-service and pre-service teacher educators to focus more on the integration of technology into pedagogy and content and for the teachers to engage in programmes that can assist them with the integration of emerging technologies.The teachers' abilities and concernsrequire intensive investigation in order to provide customised assistance to the teachers.

Keywords*: ICTs, integration of ICTs, TPACK, constructivism, CBAM, teachers' concerns, physical science,Lesotho*

Acronyms

CBAM:	Concerns-based adoption model
CD:	Compact disk
CK:	Content knowledge
DVD:	Digital video drive
ECoL:	Examinations Council of Lesotho
ICTs:	Information and communication technologies
IGCSE:	International General Certificate of Secondary Education
JC:	Junior certificate
LGCSE:	Lesotho General Certificate of Secondary Education
NCDC:	National Curriculum Development Centre
PK:	Pedagogical knowledge
PCK:	Pedagogical content knowledge
SoCQ:	Stages of concern questionnaire
TCK:	Technological content knowledge
TK:	Technological knowledge
TPACK:	Technological pedagogical content knowledge
TPK:	Technological pedagogical knowledge

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Section 1: Introduction and orientation of the study

1.1. Introduction

Manyresearchers recognise the value of information and communication technologies (ICTs) for teaching (Abdullahi, 2014; Kibirige, 2011; Mikre, 2011; Mulwa, Kyalo, Bowa & Mboroki, 2012; UNESCO, 2014). Some scholars claim that professional life and all other aspects of life in the 21st century are so complex that teachers arerequired to be competent in technology in order to use modern computer skills and ICTs in all aspects of the school curriculum on a regularbasis (Dass, 2014; Irvine, Code& Richards, 2013). Life at present and probably in future, is techno-orientated and teachers have to keep up with their learners who were born in this era of technological innovation that is sometimes vastly different from the time when many of the teachers themselves were born.

The learners often have emerging technologies at their disposal because ICTs currently have an influence on just about all areas of our lives, including schooling (Duta & Martinez-Rivera, 2015). Shahmir, Hamidi, Bagherzadeh and Salimi (2010) posit that most developed countries have ascertained how ICTs can influence educational revolution but there is less information related to the relationship between education and technology in developing countries. However, several developing countries are increasinglyinvesting funds for the introduction of information and communication technologies (ICTs) into the education system (Unal&Ozturk, 2012). In this study, the researcher argues that teachersrequire thoroughly researched ideas to guide them to be able to take advantage of this context.

Most teachers are optimistic about ICT (information and communication technology) integration as they are convinced of the ability ofICTs to improve instruction (Aslan & Zhu, 2016; Buabeng-Andoh, 2012;Kibirige, 2011). ICTs provide the education system with an alternative way of speeding up the change process and accessibility of data. ICTs are not limited by differences in time and space because they allow people in different locations anywhere in the world to communicate in real time (Koehler, Mishra, Akcaoglu & Rosenberg, 2013). ICTs also help teachers to provide useful and timely feedback to their learners to keep them fully engaged in their own learning (Wan, 2014). Most importantly, ICTs provide us with resources that aid student-to-student interaction, such as when learners are engaged in experimental activities and scientific projects. This is particularly important for this study, which focuseson physical science. This is because physical science is characterised by experiments.

The ICTs have the capability to compel schools to encourage learners to take full advantage of the potential of ICTs in their daily learning endeavours as well as in their prospectivejobs (Montelongo& Herter, 2010). Exposing children to ICTs enhances their learning experiences, hence developing their attitudes in cognitive, affective and behavioural terms. These learners are motivated to learn more and their curiosity levels are increased, thus reducing their likelihood to be involved in disciplinary challenges (Alkahtani, 2016; Peralta & Costa, 2007). The learners therefore engage more in collaboration through ICTs thus improving pedagogy in a variety of ways; learners learn in a learner-centred, constructivist setting to promote their thinking skills to a higher level (Rastogi& Malhotra, 2013). This studysought to explore the various ways by which pedagogy and social interaction could be improved, by examining the practices, knowledge and concerns of teachers related to ICT integration.

Many teachers do not use information and communication technologies (ICTs) for teaching and learning even though they may use them for other professional and personal activities (Agyei, 2013; Buabeng-Andoh, 2012; Kalanda& De Villiers, 2013; Zehra&Bilwani, 2016). Some teacherssometimes do not integrate ICTs in their teaching despite the improvements made to ICT infrastructure and teacher training programmes as well as the positive attitudes they may have towards ICTs (Hosman&Cvetanoska, 2013; Leendertz, Blignaut, Nieuwoudt, Els & Ellis, 2013; Mulwa*et al*., 2012; Rastogi& Malhotra, 2013). For instance, in the school where I teach, we have a computer laboratory and access to the Internet but these facilities are only used for computer education rather than for teaching the rest of the curriculum. All the teachers in my school have received training on computer literacy under the school-net Lesotho project but none of us applies these skills for teaching. It is then crucial to explore the teachers’ characteristics and feelings regarding the integration of ICTs into teaching.

There are many challenges that are faced by the implementation process of ICT integration. Many writers relate the lack of ICT integration to insufficient time, inappropriate software, inaccessibility of ICT resources, teachers' low confidence, lack of support, insufficient technological skills among learners and teachers' lack of skills for teaching with ICTs, among other problems (Alkahtani, 2016; Hosman&Cvetanoska, 2013; Prasad, Lalitha&Strikar, 2015; Wilson-Strydom, Thompson& Hodgkinson-Williams, 2008). Some researchers go further to attribute the problem of lack of ICT integration to curriculum limitations (Abdullahi, 2014; Lau & Sim, 2008; Peralta & Costa, 2007). These writers point out that some curricula emphasise other aspects such as content assessment without technologywhereas they do not provide subject related assistance for ICT integration. For instance, in Lesotho practical work in science is a requirement, for example, it is mentioned throughout the syllabus document while the use of ICTs for teaching is only mentioned in the aims section (Examinations Council of Lesotho, 2012). As a result, teachers tend to focus more on practical work, rather than on ICT integration. Chigona, Chigona and Davids (2014) assert that in addition to these problems the context of the school such as organisational practices can be a barrier to ICT integration, while Ward (2003) disagrees. Ward (2003) believes that teachers use their contexts to make limited choices and hence relates the argument to a lack of proper institutionalisation of ICT integration. It is of great importance to establish the challenges faced by teachers from specific contexts.

1.2. Background and rationale

Lesotho as a country has embarked on a reform programmeto try to enhance ICT integration. The Lesotho government developed a national policy on ICTs in 2005 (Lesotho government, 2005), following the launch of the national vision 2020 statement in 2002 (Lesotho government, 2002). The ICT policy provides guidance on the provision and use of technology in the country by turning the national vision statements into guidelines for stakeholders to implement. The aims of the national vision include, among others, ensuring a strong basis for technology research and development in the country. Lesotho has formally acknowledged science and technology as a priority sector for education (Lesotho government, 2005; Lesotho government, 2002; UNESCO, 2016). As a result, the country introduced the computer education curriculum at junior certificate (JC) level in 2004 through the National Curriculum Development Centre (NCDC), the aim of which is to provide learners with basic literacy in computers (NCDC, 2004). The teachers can take advantage of the computer skills that the learners may already possess by incorporating such skills into physical science.

The literature on the integration of ICTs in Lesotho shows similar trends to those in other countriesconcerning barriers to implementation even though only a few studies have been conducted in Lesotho on ICT integration into the curriculum. Lesotho science teachers experience a low rate of integration of ICTs and even those who use ICTsappear todo it for administration and preparation purposes rather than for teaching and learning (Kalanda& De Villiers, 2013).According to UNESCO (2014), learners fromthe developing countries such as Lesotho are more likely to gain knowledge of ICTs from informal settings outside the classroom than from school. The knowledge that the learners gather from such situations can be quite useful in the physical science classrooms. For instance, the use of chat rooms can be used to promote discussions among the learners.

The ICT area isconsidered as a sector for sustainable economic development in Lesotho (Morgan-Jarvis, 2015). However, Lesotho's infrastructure is quite poor due to a lack of funds and this is one of the main challenges faced by all citizens regarding the use of ICTs(Farrell, Isaacs&Trucano, 2007; Morgan-Jarvis, 2015; UNESCO, 2016). The most underdeveloped aspect of the infrastructure is broadcasting, with only one television station in the country and a few radio stations.Broadcasting is vital in the history of ICT integration, marking some of the pioneer stages because they were used long before computers for teaching (Kalanda& De Villiers, 2013). As a result, broadcasting needs to be developed to increase its integration. The most advanced aspect of infrastructure is the cellular connectivity, with an increase from 1% to 96% since the year 2000 (Morgan-Jarvis, 2015). Teachers in Lesotho need to take advantage of the present teledensity situation and integrate more hand-held devices into the curriculum.

The other reasons given by Lesotho teachers for their limited use of ICTs forteaching include problems related to software upgrading, a lack of support,a lack of skills within the Ministry of Education and Training (MoET) for monitoring the implementation of the national ICT policy and a lack of collaboration among stakeholders. Additional problems include a lack of funding and the fact that the curriculum is not contextually relevant for the country because it was adopted(Farrell*et al*., 2007; Kalanda& De Villiers, 2013). Thediversity of views to explain the lack of ICT integration have given rise to the present study, which seeks to establish theteachers' practices, knowledge and concerns related to ICTs and their integration into physical science teaching.

1.3. Context of the study

The country has recently engaged in the localisation process of the International General Certificate of Secondary Education (IGCSE) curriculum that is now referred to as the Lesotho General Certificate of Secondary Education (LGCSE). The LGCSE curriculum consists of, among others, the physical science syllabus, which is relatively new in the country and is the focus of the present study. In this syllabus, the teachers are expected to incorporate ICTs into the core curriculum to improve the value and the accessibility of education. The physical science syllabus has been linked to ICT integration only by the clause in the aims section that demands acquisition of technological and communication skills by the learners as they go about the learning of the physical science content knowledge (ECoL, 2012). However, the rest of the syllabus does not provide any guidance related to how the new technologies could be used to teach the physical science content knowledge. This study therefore proposes to explore how the teachers are responding to this call of the LGCSE curriculum for the integration of technology into their teaching and learning activities of physical science.

1.4. Problem statement

Lesotho is no exception when it comes to the limited use of ICTs for teaching (Kalanda& De Villiers, 2013).However, the government of Lesotho, as with many other governments, hasinvested a considerable quantity of resources on ICT integration such as in the localisation of the curriculum, which demands the integration of ICTs into its implementation (Unal&Ozturk, 2012). It is therefore, timely for researchers to explore what the potential challenges related to the use of ICTs are and how teachers feel about the innovation of ICT integration into the core curriculum. Teachers have a significant amount of responsibility as the major decision makers in the matters concerning how they implement education reforms (Ward, 2003:3). Therefore, this study aims to contribute insights to the understanding of the teachers' concerns regarding how they integrate and use ICTs in their daily teaching of physical science, now at the beginning years of the implementation process.

According to the aims of the LGCSE physical science syllabus, it is important to produce learners with enough knowledge and skills to become efficient members of the technological society and who are able to communicate successfully (ECoL, 2012). This syllabus, however, does not provide any guidance on how teachers should implement the integration of ICTs but it leaves the decisions to the teachers to use ICTs in ways that suit their contexts. This kind of syllabus can either be taken as an inhibiting or enhancing factor for the integration process (Peralta & Costa, 2007). Some teachers may think that the lack of guidance is a barrier that prevents their practice of ICT integration and as such, they may conform to the clear directives provided by the curriculum. These teachers may implement the curriculum in an obedient and passive manner, without reorganising it during lesson planning to allow for the use of ICTs. The other teachers may consider the lack of guidelines as an advantage of an open-ended curriculum providing them with unlimited options to use ICTs in a variety of ways on a regular basis. The present study needs to establish the teachers' practices regarding the use of the ICT-based physical science curriculum.

Spillane, Reiser and Reimer (2002) explain that what a policy means for the implementation agents is constituted by the interaction of their existing cognitive structures being their knowledge, skills, beliefs and attitudes, their working environments and the policy indicators themselves. According to them, education reform ideas, such as ICT integration into teaching and learning, are abstract concepts that require "sense-making" and "information-processing" at individual, contextual and policy level. "Policy ambiguity is often a function of coalition and consensus building in the policy development process, but it is also a function of the social problems addressed by policy makers" (Spillane *et al*., 2002:390). This statement summarises the problem that was investigated by the present study, which relates to the practices, knowledge and concerns of the Lesotho physical science teachers regarding the use of ICTs in their prevailing situations in relation to what the policy requires of them.

1.5. Aims and objectives of the study

The main aim of the present study is to determine the practices, knowledge and concerns of the Lesotho teachers from selected high schools regarding the issues surrounding the integration of ICTs into the teaching and learning of physical science. The specific objectives are as follows: The study intends to

- examine the physical science teachers' knowledge regarding the use and integration of ICTs.
- establish whether the type of knowledge they have is translated into the actual use and integration of ICTs by determining whether they use ICTs when they teach high school core curriculum physical science and how they do it if they do.
- assess the type of knowledge the teachers have regarding ICT integration. This objective is related to the testing of the first null hypothesis, which presumes that high school teachers in Lesotho do not have the types of knowledge required for the integration of ICTs into their teaching of physical science.
- describe the teachers' concerns about the use and integration of ICTs, thus testing the null hypothesis that high school teachers in Lesotho do not have significant concerns regarding the integration of ICTs into the teaching of physical science.
- explore the differences in knowledge and concerns between various groups of teachers. The groups depend on the teachers' age, gender and years of teaching experience as well as the type and geographical location of the school.

The present study therefore tested the following null hypotheses:

1. high school teachers in Lesotho do not have the type of knowledge required for the integration of a variety of ICTs into their teaching of physical science and

2. high school teachers in Lesotho do not have significant concerns regarding the integration of ICTs into the teaching of physical science.

1.6. Research questions

The purpose of the present study was addressed through the following research questions:

- What are the practices of the physical science teachers in Lesotho high schools regarding the use and integration of ICTs?
- Which modern technologies do the teachers use and how do they use them?
- What type of knowledge do the teachers have with regard to the integration of ICTs?
- How can the type of concerns that the teachers have in relation to the use and integration of ICTs be described?
- In what ways are the teachers' knowledge and concernsrelated to their gender, age, teaching experience, type and geographical location of school, if at all?

1.7. Framework of the study

The present study was based on three theoretical frameworks, namely constructivism, the technological pedagogical content knowledge (TPACK) model and the concerns-based adoption model (CBAM).

1.7.1. Constructivism

The first framework used in this study is the theory of constructivism,which supports the integration of ICTs into the curriculum in ideology and pedagogy (Peralta & Costa, 2007). This implies that teaching with ICTs is pedagogically constructivist in nature while integrating ICTs ideologically allows teachers to be professional and autonomous. Constructive learning is a continuous process rather than a product, thus resulting in a change in traditional roles of learners as passive acceptors and reproducers of knowledge(Rastogi& Malhotra, 2013). Integration of ICTs helps learners become active planners, implementers and evaluators of their own learning, which is achieved through constructive learner-centred approaches of learning

(Koohang*et al*., 2009). This promotes lifelong learning and facilitates the transition of ICT integration into the work place. The concept of continuity is important for this paper because it relates to the examination of the teachers' progress on the adaptation to the changing demands of the education system. The detailed description of the two types of constructivism has been provided in article 1 (p.21).

This study focused on teachers' display of the design elements of Koohang*et al*.'s (2009) model of constructivism learning theory in e-learning environments, namely fundamental and collaborative design elements. The elements of this theory are outlined in article 1 (p.22) and their diagrammatic representationis also provided (see fig. 1, p.23).

1.7.2. The technological pedagogical content knowledge model

The second framework underpinning this study is technological pedagogical content knowledge (TPACK). The model recognisesthe complicated character of teachingcaused by various types of knowledge, including among others, understanding the educational programme and the learners' ways of thinking and learning, which have to be reconciled (Mishra & Koehler, 2006). It is therefore important to study how Lesotho teachers'contexts influence their ICT integration.The researcher employed the TPACK questionnaire to study the integration of ICTs and analysed the quantitative data obtained by determining the mean and other descriptive statistical analyses.

The model and its applications have been elucidated in article 1 (p.23). The constituent types of knowledge for the TPACK model are also detailed in article 1 with the aid of a diagram (fig. 2, p.25).

1.7.3. The concerns-based adoption model

The third and last framework that guided the present study is the concerns-based adoption model (CBAM). CBAM was employed as the foundation for this study owing toits wide employmentin the promotion and facilitation of innovations from the personal standpoint (Sultana, 2015; Yidana&Maazure, 2012). This point is evident, as it has been employed as the theoretical foundation in a number of studies

(Centikaya, 2012; Christou, Eliophotou-Menon &Philippou, 2004; Dunn, Airola,& Garrison, 2013; Hosman&Cvetanoska 2013).

CBAM is a substantiated creation providing instruments with the potential to be used for assessing the extent to which a person, school or district has advanced into the implementation process to avoid innovation resistance or rejection(Hall, 2010; Hall &Hord, 2011). The details of the model have been explained in article 2 (p.51).The demand for the teachers to integrate ICTs into the instruction of physical science necessitates the exploration of their concerns as the implementation process begins so that it can be followed up in due course as they learn, and hence, change their stages of concern. The summary of the stages of concern (SoC) is given in table 1 (refer to article 2, p. 53).

1.8. Significance of the study

The present study sought to close the gaps in the existing literature as well as to contribute to the body of knowledge in various ways. Firstly, the study wished to provide some of the information that will guide the implementation of the integration of ICTs into the education system in the form of the concerns and knowledge that the teachers have.Secondly, this study aspired to find out whether and how the Lesotho physical science teachers are using ICTs to take advantage of these benefits that modern technology offers.

The existing study attempted to explore the dynamics of the subject of ICT integration and contribute to the process of regularisation of research in the country. Although quite a few studies have been conducted in Lesotho on the integration of ICTs, there is a gap in terms of the focus. For instance, Chere-Masopha (2011) explored ICT integration by secondary level teachers of all subjects but this paper focuses on physical science teachers. Olatokun and Ntemana (2015) studied ICT integration by university lecturers of all subjects rather than high school science which was the focus of the present study. A methodological gap also exists regarding research on ICT integration in Lesotho. For instance, Kalanda and De Villiers (2013) approached their study through a participatory action research design while Ntoi (2007) conducted a case study. The current study undertook a quantitative survey study on the subject of ICT integration.

Most of the literature also provides information primarily on the use of computers such as the studies of Peralta and Costa (2007) and Ward (2003) and not on the wide array of ICTs that may include tablets, mobile phones and digital cameras, among others. Other studies have focused on the use of specific technologies such as video-conferencing (Martinovic, Pugh &Magliaro, 2010) and interactive whiteboards (Hall, 2010). This study therefore proposed to identify the different ICTs that may be used by teachers as they deliver their physical science instructional activities.

As it has already been revealed, ICT integration in Lesotho is a matter of policy implementation because the national ICT policy demands ICTs be incorporated into the core curricula (Lesotho government, 2005). Sife, Lwoga and Sanga (2007) confer that the integration of ICTs in the operation of any institution is complicated and therefore requires to be completely described for all the stakeholders to understand as the implementation process starts. It is therefore important for this study to haveinterrogated the concerns of teachers regarding ICT integration into physical science education.It is particularly imperative to explore the concerns at the beginning stages of the implementation process in order to contribute to the information that may help enhance improvement and increase innovative use of ICTs in time.

It is hoped that the information gathered from this study will help many stakeholders of the education system such as the National Curriculum Development Centre (NCDC) to incorporate the perceptions of teachers regarding the use of ICTs in their plans of curriculum development. This is particularly important because the country of Lesotho needs to develop its own curriculum for high school level besides the localised one, which has been adopted rather than adapted from elsewhere.

Some teachers have attributed their lack of ICT integration to a shortage of training or not being appropriately trained (Koehler, Mishra & Cain, 2013; Prasad *et al.*,2015). This shows that teachers perceive training as an integral part of their development of confidence and positive attitudes towards ICT integration. It therefore implies that the in-service and pre-service training providers may also benefit from the present study because they will learn of the teachers' needs. As a result, they may decide to incorporate them in their programmes or even use the findings of this study as a basis for further research of their own, particularly because of Takona's (2002) argument that survey studies form a good base for more detailed research.

The teachers of different subjects may also benefit from the present study by learning from the experiences of other teachers to improve their own practice. The teachers who may benefit include those teachers who are within the study and those who are not participating in the study. The teachers may also benefit if training programmes and curriculum statements are improved because of the study. They may also benefit if the induction programme providers make use of the findings of the study to improve their schedules of helping the novice teachers as they begin their careers to have the optimum impact, with the potential of increasing the use of ICTs with time.

At a more personal level, the study will help me in my capacity as an experienced teacher and head of mathematics and science department, in my daily instructional leadership activities. The findings and experiences of this study will also help me more as a physical science classroom teacher to gather information that I can immediately implement to change my teaching strategies in ways that will improve my teaching and hopefully my learners' skills as well.

1.9. Research methodology

1.9.1. Research approach, paradigm, design and process

The paradigm that guided the present study is post-positivism and the researcher followed the deductive quantitative approach. The researcher applied the descriptive non-experimental survey design.Post-positivism allowed the researcher to be objective, logical and systematic when testing the hypotheses while the descriptive non-experimental survey design enabled the researcher to focus on the purpose of the study (Mulwa*et al*., 2012).The non-experimental survey design also allowed for a large population of teachersto be explored by examining only a sample because it is flexible and adaptable. This principle further enabled the researcher to describeICT integration without controlling the school contexts or describing the cause-effect relations between teachers' knowledge or concerns and teachers' age, teaching experience, gender or place of work (Johnson & Christensen, 2014).The existing study is applied research,which permitted the researcher to make sense of the characteristics of ICT integration for the current cohort of physical science teachers (Takona, 2002).

1.9.2. Sample and sampling techniques

The StatTrek table of random numbers was utilised to select a cluster sample comprising 23 schools (with 76 physical science teachers) (StatTrek, 2016). The study was conducted in five of the ten districts of Lesotho, namely Mafeteng, Maseru, Berea, Leribe and Mokhotlong. These districts provided a fair representation of the entire population from 138 high schools in terms of their demographics, particularly the geographical location of the school, which may affect availability of technological resources and knowledge as they consist of the highlands and the lowlands. The demographic details of the sample of 76 teachers are outlined in the two articles (refer to article 1, table 1, p. 29 and article 2, table 2, p. 57).

The random sample was chosen for its potential to produce questionnaire results thathave the precision, effectiveness, validity and reliability required to enable the researcher to apply the conclusions to the entire population of physical science teachers (Mathers, Fox&Hunn, 2009). The random sampling technique minimised research costs and time while still ensuring reasonable representation of the population (Creswell, 2013). The cluster method was employed because the individual teachers were located in geographically separated places that would otherwise be quite difficult to reach. The cluster method of the one-stage basic type was chosen because each school had only a few physical science teachers. Consequently, all the physical science teachers in the sampled schools were asked to participate in the study.

1.9.3. Data collection and analysis

The respondents filled in a written questionnaire consisting of 50 close-ended items for the data collection. The data collected included respondents' demographic details, teachers' use of various technologies, type of knowledge and concerns regarding the integration of ICTs. The questionnaire used in the present study (see appendix 4) was an adaptation of the two instruments namely, the stages of concern questionnaire (SoCQ) and the technological pedagogical content knowledge (TPACK) survey instrument (Christou *et al*., 2004; George, Hall &Stiegelbauer, 2006; Mishra & Koehler, 2006). The items from the two tools were selected and adapted to the context of the present study namely ICT use and integration.

Items1 to 21 were based on CBAM's stages of concern questionnaire (SoCQ) and they had an8-point Likert scale of responses. Weightings of the answers on the SoCQ ranged from 0=irrelevant to 7=very true of me now. Items 22 to 44 were based on the TPACK survey instrument with a 5-point Likert scale of responses. Weightings of the answers on the TPACK questionnaire ranged from 1 = no knowledge at all, to 5 = complete knowledge. Items 45 to 50 were employed to establish the physical science teachers' use of ICTs. Items 45, 46 and 48 identified the ICT resources used. Items 47 and 50 were meant to determine the rate of use of ICTs and they had a 5-point scale with the rating range from 1= none at all, to 5= always. The last part of the questionnaire required the demographic information of the sampled teachers. The questionnaires were delivered to the respective schools and then collected as soon as they had been filled in. The last weighting point (11 = no response) was added to the scale for all the items to cater for the responses which were not provided solely for purposes of data analysis (see appendix 6 on page 99).

The researcher used the statistical analysis software (SAS) procedure frequency to calculate frequencies and the corresponding percentages of the responses to the biographical questions (SAS, 2013). This software seems to be widely used in recent years, particularly in research related to ICT integration (Alkahtani, 2016). The researcher also calculated the description statistics for the mean scores of the entire sample (All) and by gender, age group and teaching experience, type of school and location of school. This was achieved through the SAS procedure TABULATE (SAS, 2013).

The respondents were grouped into various categories for the biographical variable in question because all the biographical variables were categorical. The mean for the different domains (stages of concern or types of knowledge) of the demographic groups was contrasted through one-way analysis of variance (ANOVA) using the SAS procedure general linear model (SAS, 2013). The sum score in question was the dependent variable whereas the stipulated biographical variable was the single factor in the ANOVA model.

1.10. Ethical considerations

Firstly, permission to undertake this study was granted by the Faculty of Education of the University of the Free State. Secondly, permission to involve teachers in the study was sought in writing from the Lesotho Ministry of Education and Training and from the respective school principals. Participation was strictly voluntary (Leedy&Ormrod, 2005). The willing respondents were requested to complete a consent form that emphasised the significance of the study and potential risks as well as their right to participate in and to refrain from participation at any time. The respondents were not exposed to any possible harm. Privacy and confidentiality were observed by using numbers on the research instruments and keeping all the completed questionnaire forms in a safe place (Johnson & Christensen, 2014). Honesty was achieved by declaring all the relevant information regarding the purpose of the study.

1.11. Limitations of the study

The study does not claim that it has discovered new concepts because science as a subject has always been taught in Lesotho and elsewhere in the world, which means that there is a lot of existing information related to the integration of ICTs into the teaching and learning of the subject. All that the study intended to do was to add to the already existinginformation, more specifically regarding the current cohort of physical science teachers in Lesotho.

The fact that the study is a survey also posed some problems, as the response rate was lower than what was anticipated (Johnson & Christensen, 2014). This therefore means that the final sample may not have been a true representation of the population. This limitation was compensated for by the fact that the sample waslarge enough and well-adjusted beforehand to cater for the respondents who opted out of the sample as well as all the teachers from various groups.

1.12. Clarification of terms

Constructivism is a learning theory stating that learners actively use their pre-knowledge to construct new ideas (Koohang*et al*., 2009).

Physical science is a component of the two-year high school level curriculum that consists of physics and chemistry.

Integration of ICTsdescribes the use of the ICT resources for teaching and learning by incorporating them into daily classroom activities (Wilson-Strydom *et al*., 2005)

Concerns refer to a complex display of one's own perceptions and ideas about a specific matter (Hall *et al*., 1991).

Information and communications technologies (ICTs, singular form of which is ICT)are the changing and prevalent computing, information and communications technology equipment and services such as computers, telecommunications, broadcasting, multimedia, software development, e-publishing, information storage and retrieval and Internet, among others, used for communicating, creating, disseminating, storing and managing information (Lesotho government, 2005;Mulwa*et al*., 2012).

Concerns-based adoption model (CBAM)is a framework that provides thoroughly researched principles and instruments capable of use for understanding, facilitating and evaluating the complexity of the introduction of reforms (Hord, 2010).

Stages of concern questionnaire (SoCQ)is a tool designed for the assessment of the seven assumed stages of concern regarding a reform (Hall, George& Rutherford 1977).

Technological pedagogical content knowledge is a framework that advocates for the application of pedagogical practices that employ technology constructively in delivering the content (Mishra & Koehler, 2006).

1.13. Outline of the Dissertation sections

This is an articles-based dissertation which presents “two potentially publishable articles” (University of the Free State, 2016) instead of the traditional chapters.

The dissertation contains three sections, viz. section one which presents the introduction and orientation to the study, section 2 which presents the two articles to be submitted to journals for possible publication and section 3 which concludes the dissertation by showing how each research question was answered through the two articles.Each article is presented in the format and referencing style required by the specific journal that is targeted for publication. The titles of the articles are as follows:

Article 1: The integration of modern technologies into the teaching of physical science in Lesotho high schools

Article 2: Teachers’ concerns on the integration of information and communication technologies into physical science in Lesotho

Section 2: The articles

ARTICLE 1

The integration of modern technologies into the teaching of physical science in Lesotho high schools

Abstract

The aim of the present paper is to explore the practices and knowledge of physical science teachers from selected Lesotho high schools regarding the integration of information and communication technologies (ICTs) into the curriculum. The knowledge of ICTs for teaching has recently become increasingly important because of the impact of ICTs on our daily lives. The new physical science curriculum in Lesothorequires the use of ICTs for teaching. The use of ICTs was explored through a questionnaire based on the technological pedagogical content knowledge model (TPACK). Statistical analysis software (SAS) was employed to analyse the quantitative data that was obtained. The results revealed that 77% of the teachers used ICTs such as mobile phones, computers and the Internet for teaching while 80% used them outside the classroom. This means that many teachers use ICTs even though they use them more for non-teaching activities than for teaching itself. The mean score for teachers' TPACK was 2.88. This score is below the average of threefor the points on the Likert scale of the items on teachers' TPACK, which was set as the acceptable level for this paper. Therefore, the study concludes that Lesotho teachers integrate ICTs into their teaching of physical science even though their TPACK may be below average, partlydue to some challenges that they face in their classrooms. There is thusan urgent need to increase the support for teachers in order to maximise the use of ICTs for teaching as well as the variety of technologies being used.

***Keywords**: ICTs, TPACK, constructivism, physical science, teachers' knowledge, Lesotho*

Introduction

Many scholars (Abdullahi, 2014; Kibirige, 2011; Mikre, 2011; UNESCO, 2014) have established the importance of information and communication technologies (ICTs) for teaching. Learners are often surrounded by modern technologies; hence, the need for educators to pay attention to and take advantage of ICTs in the teaching and learning context. Researchsuggests that most teachers are optimistic about ICT integration as a strategy to improve instruction(Aslan & Zhu, 2016; Peralta & Costa, 2007). However, in practice some teachers struggle to translate their positive attitudes into actual ICT integrationdespite the improvements made to ICT infrastructure and in the teacher training programmes (Buabeng-Andoh, 2012; Rastogi& Malhotra, 2013; Zehra&Bilwani, 2016). The teachers oftenidentifybarriers such as a lack of confidence, insufficient time, inappropriate software, inaccessibility of ICT resources, limitations of the curriculum, insufficient support and a lack of knowledge related to ICT integration, among others (Alkahtani, 2016; Prasad, Lalitha&Strikar, 2015). Teachers who displaypositive attitudes are more likely to be willing to overcome some of the barriers, either individually or in collaboration with others as they pursue ICT integration.

Researchers view the lack of integration of ICTs from different angles. While it is arguably true that ICT infrastructure and technical training are among the factors that have a positive influence on the integration of ICTs, some writers believe that the introduction of ICTs and teachers' technical training may not be enough to guarantee efficacy of ICT integration(Chigona, Chigona&Davids, 2014; Hosman&Cvetanoska, 2013;Leendertz*et al*., 2013; Ward, 2003). Chigona*et al*. (2014) furtherassert that the context of the school can be a barrier to ICT integration. Ward (2003), however, believes that it is the teachers who use their contexts to make limited choices and relates the problem of lack of ICT integration to inadequate institutionalisation. Leendertz*et al.* (2013), on the other hand, relate the problem to a lack of competence among teachers while Hosman and Cvetanoska (2013) argue that teachers are not provided with enough support. In the absence of conclusive evidence one way or the other, it is therefore important to continue with investigations of the practices and knowledge of teachers and the contexts of teaching, among other factorsthat are relevant to ICT integration. It is in this context that this paper examinesone group of teachers' practices and knowledge related to ICT integration into physical science teaching in Lesotho. Although quite a few studies have been conducted in Lesotho on the integration of ICTs, there are somedistinctgaps. Firstly, there is a gap in terms of the focus. For instance, Chere-Masopha (2011) explored ICT integration by secondary level teachers in general with no specific subject focus such as physical science. The focus on physical science is important in the context of the country's curriculum framework that specifically advocates for such integration. Similarly, Olatokun and Ntemana (2015) studied ICT integration by university lecturers in general.Secondly, a methodological gap exists regarding research on ICT integration in Lesotho. For instance, Kalanda and De Villiers (2013) approached their study through a participatory action research design while Ntoi (2007) conducted a qualitativecase study. The present article takes a different approach by presenting data from a quantitative survey study on the subject of ICT integration in the teaching of physical science in particular.The following research questions are explored:What are the practices of the physical science teachers in Lesotho high schools regarding the use of ICTs? Which modern technologies do they use and how do they use them? What type of knowledge do they have with regard to the integration of ICTs in their subject?The research testedthe null hypothesis that high school teachers in Lesotho do not have the types of knowledge required for the integration of a variety of ICTs in their teaching of physical science.

Background to the study

The lack of knowledge on ICT integration into daily instructional activities is a global challenge (Lau & Sim, 2008). In Lesotho, this lack of knowledge is intertwined with the shortage of technical support because the officials inthe Ministry of Education and Training (MoET) often do not have the necessary understanding of ICT integration (Farrell, Isaacs&Trucano, 2007). This implies that the officials may not be able to sufficiently assess and superviseteachers' improvement related to the implementation process of ICT integration.

The role of ICTs in supporting growth and development in Lesotho has been enshrined in several policypronouncements(Morgan-Jarvis, 2015). For instance, the policy on the use of ICTs was developed in 2005 to guide the provision and use of technology in the country. The government of Lesotho has earmarked institutions of learning, including high schools, as some of the main role-players in the implementation of the national ICT policy (Lesotho government, 2005). The aims of the national vision 2020, which is the basis for the ICT policy, include ensuring a strong foundation for technology research and development in the country (Lesotho government, 2002). This aim emphasises a strong link between science and technology curricula, which is part of the reason for conducting the present study onhow teachers integrate technology into physical science teaching.

A lack of infrastructure is still a major inhibitor of ICT integration in Lesotho (UNESCO, 2016). Despite the infrastructural challenges, teachers are expected to incorporate ICTs into the core curriculum. For example, theLesotho school examining body as well as the examinations council of Lesotho (ECoL) expects physical science teachers to integrate ICTs when they deliver content knowledge (ECoL, 2012). The physical science syllabus forms part of the new Lesotho general certificate of secondary education (LGCSE) curriculum. The objectives of the syllabus demand acquisition of technological and communication skills by the learners. The physical science syllabus, which dates back to 2012, is the focus of this paper. The paper explores how teachers respond to the call by the LGCSE curriculum for the use of ICTs in the teaching and learning of physical science.

We begin with a discussion of the relevant literature and frameworks that guided the study. Then the research methodology is described in detail before presenting the findings, analysis and discussion. The paper ends with the conclusions and some recommendations.

Theoretical framework and literature review

The present study was based on two theoretical frameworks, namely constructivism and the technological pedagogical content knowledge (TPACK) model.

Constructivism

ICT integration is consistent with both types of constructivism namely cognitive constructivism and social constructivism. Cognitive constructivism can be described as guiding learners to interpret their own experiences to formulate new knowledge (Wan, 2014). Teaching with the principles of constructivism is learner-centred and keeps the learners engaged in their own learning (Wang, 2008). Researchers such as Drijvers*et al*. (2013) have studied how mathematics teachers adapted to and adopted new technologies with their learners under the framework of constructivism. Similarly,the present study therefore examined the integration of ICTs in an attempt to study how ICTs are being used for active learning as supported by cognitive constructivism.

Social constructivism can be described as teaching in an environment that is conducive for learning contextually and authentically (Lever-Duffy & McDonald, 2011). Integration of ICTs provides learners with a social environment in which they combine their understandings to discover various ways of representing knowledge. ICTs provide such an environment by enabling the learners to learn in a collaborative setting where they cooperate, interact and communicate amongst themselves and with subject experts. For instance, Mouza*et al*. (2014) employed social constructivism as their framework to studyhow learning in a computer-based environment influenced student teachers' performance. The principles of social constructivism, namely cooperation, interaction and communication are relevant for this study because they can be promoted through ICTs.

The model of constructivism learning theory in e-learning environments shows design elements and assessment elements as its main components. There are two types of design elements namely the fundamental elements and the collaborative elements. The fundamental elements include exploration, high-order thinking skills, learners' pre-knowledge, authentic examples and scaffolding. Collaborative elements include social interaction and cooperation. The assessment elements include self-, group and teacher (facilitator) assessments. This model shows that constructivism and ICT integration are two completely related concepts. This study focused on teachers' display of the fundamental and collaborative design elements of the model. The model is diagrammatically depicted as follows;

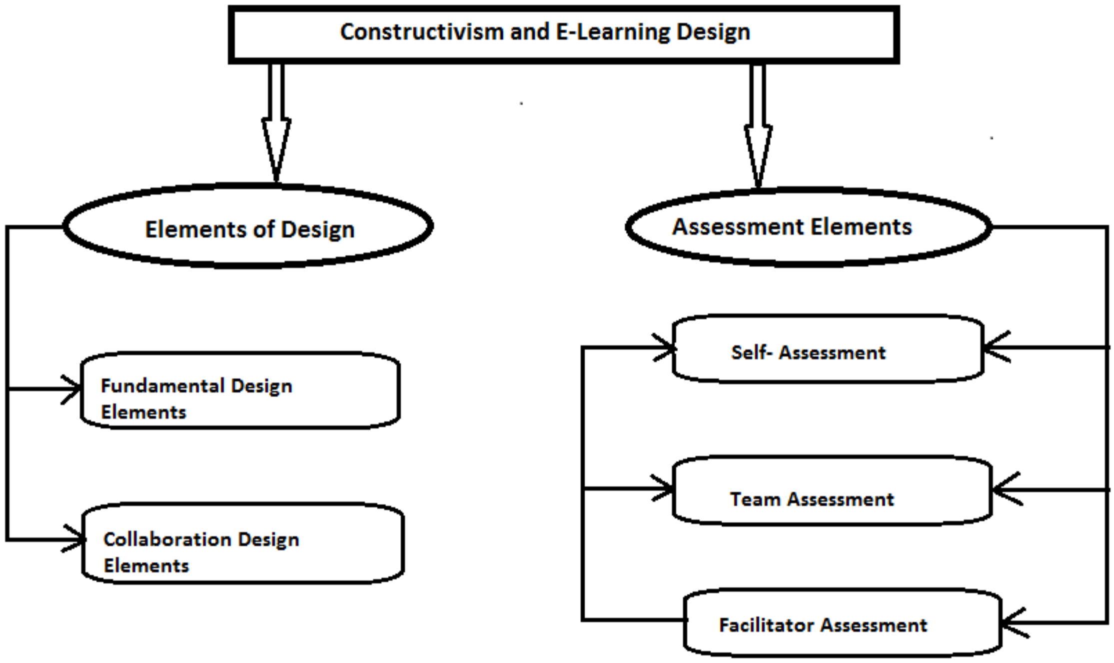

Figure 1: Constructivism elements and e-learning design learning activities; Adapted from Koohang*et al*. (2009:95)

The technological pedagogical content knowledge model

The technological pedagogical content knowledge (TPACK) model was proposed by Mishra and Koehler in 2006 to provide a framework through which peoplecould deal with complicated challenges ofICT integration(Koehler & Mishra, 2008). Teaching is complicated because it is based on various types of knowledge, including understanding the educational programme and the learners' ways of thinking and learning (Chai *et al*., 2013; Mishra & Koehler, 2006). This means that the types of knowledge are highly contextualised because they are affected by people's culture, socio-economic status and ability to plan, among other factors (Harris & Hofer, 2011). The surfacing of digital ICTs forms part of the current context and hence necessitated the addition of technological knowledge (TK) by Mishra and Koehler to Shulman's original idea of pedagogical content knowledge (PCK).

In addition to its potential to be used to explain the complex nature of the integration of ICTs into teaching, the TPACK model also allows teachers to reflect on their own practice for professional development (Messina &Tabone, 2012; Shu, 2016).

Consequently, the TPACK model has been widely used to explore the use of ICTs by pre-service and in-service teachers (Maher, 2013). However, most TPACK studies observed pre-service teachers rather than in-service teachers. Most TPACK studies also dealt with the integration of ICTs into general teaching rather than teaching of individual subjects (Chai*et al*., 2013; Wu, 2013). This paper thus focused specifically on the integration of ICTs by the current cohort of physical science teachers. The TPACK questionnaire was used to study the use of ICTs and the quantitative data that was obtained were analysed by determining the mean and other descriptive statistical analyses.

The types of knowledge can be represented as shown in figure 2. The main circle represents all the contexts that influence the types of knowledge. The three circles represent the main categories of knowledge i.e., technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK). The main categories of knowledge intersect in pairs to form three more types of knowledge, namely technological pedagogical knowledge (TPK), technological content knowledge (TCK) and pedagogical content knowledge (PCK). All three main categories interconnect to form the technological pedagogical content knowledge (TPACK).

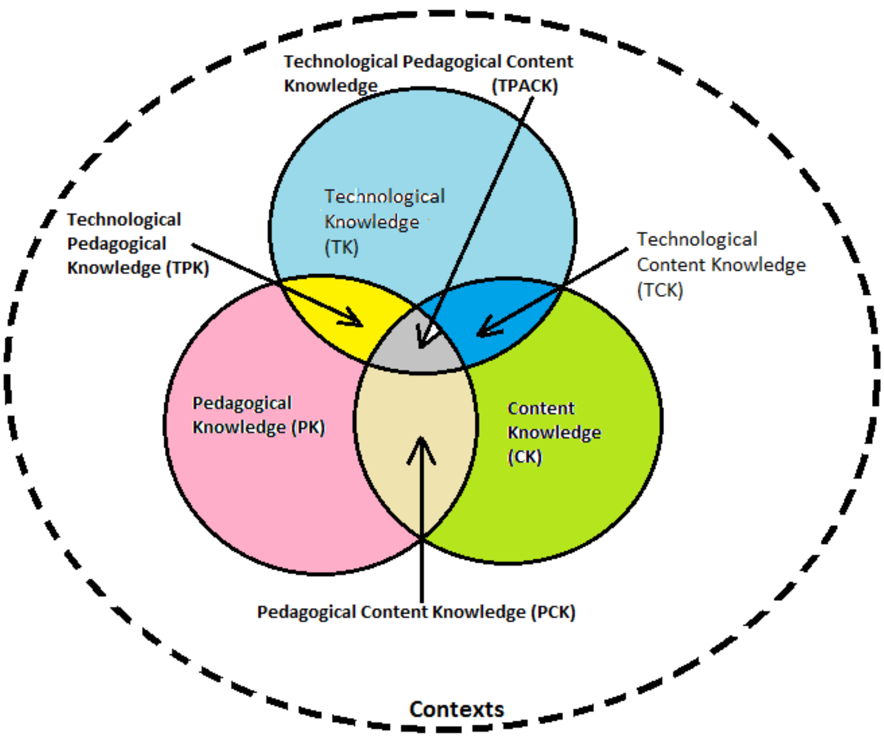

Figure 2: Technological pedagogical content knowledge (TPACK) model. Adapted from Koehler *et al*. (2013:3)

Methodology

Research approach, paradigm, design and process

The present study followed the quantitative approach, a deductive paradigm that is guided by post-positivism. Post-positivism allowsresearchers to be objective, logical and systematic when testing the hypothesis while the descriptive non-experimental survey design enablesthem to be focussed on the purpose of the study (Mulwa*et al*., 2012). The non-experimental survey design also allowedthe researcher to explore a large population of teachers by examining only a sample because of its flexibility and adaptability. This principle further allowed for the description of ICT integration without manipulating the school contexts or explaining the cause-effect relations between teachers' knowledge and teachers' age, teaching experience or gender (Johnson & Christensen, 2014). This study included applied research specifically designed to enhanceconceptualisation of the characteristics of ICT integration for the current group of physical science teachers (Takona, 2002).

Sample and sampling techniques

Arandom cluster sample, comprising of 23 schools (with 76 physical science teachers) was selected using the StatTrek table of random numbers (StatTrek, 2016). The study was conducted in five of the ten districts of Lesotho, namely Mafeteng, Maseru, Berea, Leribe and Mokhotlong. These districts provided a fair representation of the entire population of teachers from 138 high schools in terms of their demographics, particularly the geographical area or school location that may affect availability of technological resources and knowledge as the districts together consist of the highlands and the lowlands.

A questionnaire based on random sampling has the accuracy, efficiency, validity and reliability required for generalising the conclusions of the study to the entire population (Mathers, Fox&Hunn, 2009). This sampling technique minimised research costs and time while still ensuring reasonable representation of the population (Creswell, 2013). The cluster method was employed because the individual physical science teachers were located in geographically separated places that would otherwise be quite difficult to reach. The cluster method of the one-stage basic type was chosen because each school had only few physical science teachers. Consequently, all the physical science teachers in the sampled schools were asked to participate in the study.

Data collection and analysis

The respondents filled in a written questionnaire consisting of 29 closed-ended items. The data collected from 76 physical science teachers' included their demographic details as well as their knowledge and use of technologies. Items 1 to 23 were based on the TPACK model with a 5-point Likert scale of responses. Weightings of the answers on the questionnaire ranged from 1 = No knowledge at all to 5= Complete knowledge. Items 24 up to 29 were employed to establish whether the physical science teachers are integrating ICTs into teaching. These items also had a 5-point scale with the rating range from 1= None at all to 5= Always. The questionnaires were delivered to the respective schools and then collected as soon as they had been filled in, even though some were either not completed in full or were not filled at all. As a result, the last weighting (11 = no response) was included to aid the analysis of the results.

Frequencies and the corresponding percentages of the responses to the biographical questions were calculated using the statistical analysis software (SAS) procedure frequency (SAS, 2013). This software seems to be widely used in recent years particularly in research related to ICT integration (Alkahtani, 2016).

Descriptivestatistics were calculated for the mean scores for the entire sample (‘All’) and by gender, age group, teaching experience, type of school and location of school. This was achieved through the SAS procedure TABULATE (SAS, 2013).

The respondents were grouped into various categories of the biographical variable in question because all the biographical variables were categorical. The mean for the different domains (types of knowledge) of the demographic groups was contrasted through one-way analysis of variance (ANOVA) using the SAS procedure general linear model (SAS, 2013). The sum score in question was the dependent variable whereas the stipulated biographical variable was the single factor in the ANOVA model.

Ethical considerations

The ethical clearanceto undertake this study was granted by the Faculty of Education at the University of the Free State. Permission to involve teachers in the study was sought in writing from the Lesotho Ministry of Education and Training and from the school principals. Participation was strictly voluntary (Leedy&Ormrod, 2005). The willing respondents were requested to complete a form of consent emphasising the significance of the study and potential risks as well as the respondents’ right to participate in and/or withdraw from the study at any time. The respondents were assured that they would not beexposed to any possible harm. Privacy and confidentiality were observed by using numbers on the research instruments and keeping all the completed questionnaire forms in a safe place (Johnson & Christensen, 2014). Honesty was achieved by declaring all the relevant information regarding the purpose of the study.

Reliability and validity

A pilot study was conducted on ten teachers from neighbouring schools to enable the identification of possible shortcomings in the research design and instrument. This allowed the required adjustments to be made in order to have a high rate of response and reduce the likelihood of erroneous answers. For instance, some items were shortened and simpler words were used to replace the ones which were cited as challenging. These corrections helped the researcher to enhance the reliability and validity of the study. The effect of confounding variables of the study, such as teachers' age, gender and teaching experience, type of school and location of school on the teachers' knowledge and use of ICTs was explored. This enhanced the internal validity of the study while the external validity was enhanced by ensuring a randomised selection of the sample (Bhattacherjee, 2012).

The results of the Cronbach's alphas ranged between 0.69 and 0.90 thus showing that the items in all the domains of knowledge were reliable for measuring teachers' knowledge (Tavakol&Dennick, 2011). The reliability coefficients for the various types of knowledge in the instrument used in the present paper are comparable with those obtained by Schmidt *et al*. (2009) which ranged between 0.82 and 0.92.

Results and discussions

The results of the teachers' practices and knowledge regarding the integration of ICTs into teaching are stated, then discussed and presented in tables and charts. The results on the use of ICTs will be addressed first, followed by the knowledge of teachers related to the integration of ICTs into the curriculum.

Demographic data

Table 1shows the demographic details of the sample. The number of males (69.01%) was higher than that of females (30.99%). The following groups of teachers were also larger than the rest of the groups within the same variable; teachers aged between 30 and 39 (53.42%), teachers with 5 to 14 years of experience (51.39%), teachers from church schools (80.82%) and teachers from schools in the urban lowlands of the country (51.39%). The totals of teachers in various categories are different because some of the teachers did not provide some of their demographic details as shown in table 1.

Table 1: Teacher's demographic data

		Frequency	Percentage
Age (Missing =3)	20-29	15	20.55
	30-39	39	53.42
	40-49	13	17.81
	50+	6	8.22
	Male	49	69.01
	Female	22	30.99
	0-4 yrs.	20	27.78
	5-14 yrs.	37	51.39
	15-24 yrs.	11	15.28
	25+ yrs.	4	5.56
	Government	9	12.33
	Church	59	80.82
	Community	5	6.85
	Lowlands urban	37	51.39
	Lowlands rural	27	37.5
	Highlands urban	6	8.33
	Highlands rural	2	2.78

The use of ICTs

The results in table 2below show that 77% of the teachers in the sample used ICTs for teaching and 80% used them for non-teaching activities. This shows that most of the teachers used ICTs even though they used them for different purposes. The number of teachers who used ICTs for non-teaching activities was slightly higher than the number of those who used them for teaching.

The mean of the Likert points is 3 which is the sum of all five points divided by 5 (1 + 2 + 3 + 4 + 5 = 15 ÷ 5 = 3).This was set as the acceptable level of responses for this paper (Nwanekezi, Onyekuru & Oragwu, 2011). The mean scores for the frequency of the use of ICTs were 2.5 for teaching activities and 3.4 for non-teaching activities.

The mean of 2.5 for teaching activities indicates that teachers' use of ICTs range between once a term and once a weekas described in the research questions. This mean was slightly below the acceptable level of responses (M = 3). The mean of 3.4 for non-teaching activities indicates that teachers' use of ICTs was between once a week and every other day, which was slightly above the acceptable level of 3. These findings indicate that teachers indeed have some technological skills which they employ inside and outside their classrooms even though they use them more often for other professional commitments than they do for teaching. Their integration of ICTs into teaching requires more consideration for improvement.

The standard deviations were 1.08 for teaching activities and 1.15 for non-teaching activities. These results demonstrate that in both cases the results were close to the mean and therefore the two extremes on the questionnaire (viz. that the teachers used ICTs daily or avoided using them altogether), were not common. These results were to be expected, as Kalanda and De Villiers (2013) observe that the use of ICTs in Lesotho is increasing. The fact that teachers used ICTs more for non-teaching activities than they do for teaching itself and that they only use the ICTs occasionally may be regarded as an indication that they may be using the technologies to perform their usual traditional duties (Haddad, Ferreira&Faria, 2014; Hennessy, Ruthven& Brindley, 2005). For instance, they may be using the Internet to strengthen their content knowledge rather than using it in the classroom with the learners.

Table 2: The results of the practices of teachers regarding whether they use ICTs and how often they use them

		Teaching activities	Non-teaching activities
	Positive	77%	80%
	Negative	33%	20%
	Mean	2.5	3.4
	S. dev.	1.08	1.15

Furthermore, theresults also show the numbers of teachers using various technologies as 67 for mobile phones, 62 for the Internet and 60 for computers **(**see figure 3below**)**. Ten teachers used digital cameras, 11 teachers used scanners and 12 teachers used CDs. This shows that mobile phones, the Internet and computers were among the technologies that were mostly used in schools, while digital cameras, scanners, CDs and DVDs were among those that were rarely used. The rest of the technologies were used in moderation. Digital cameras were probably not widely used because smart phones and computers have built-in cameras, which are more convenient to use. CDs and DVDs were probably replaced with flash drives, which are more durable. This also demonstrates that teachers probably used mobile phones more than computers to access the Internet. This was to be expected because teachers have more access to their mobile phones than to the school computers. They access the Internet and other services more easily through their phones, thus reducing the problem of a lack of access to ICT resources (Mulwa*et al*., 2012).

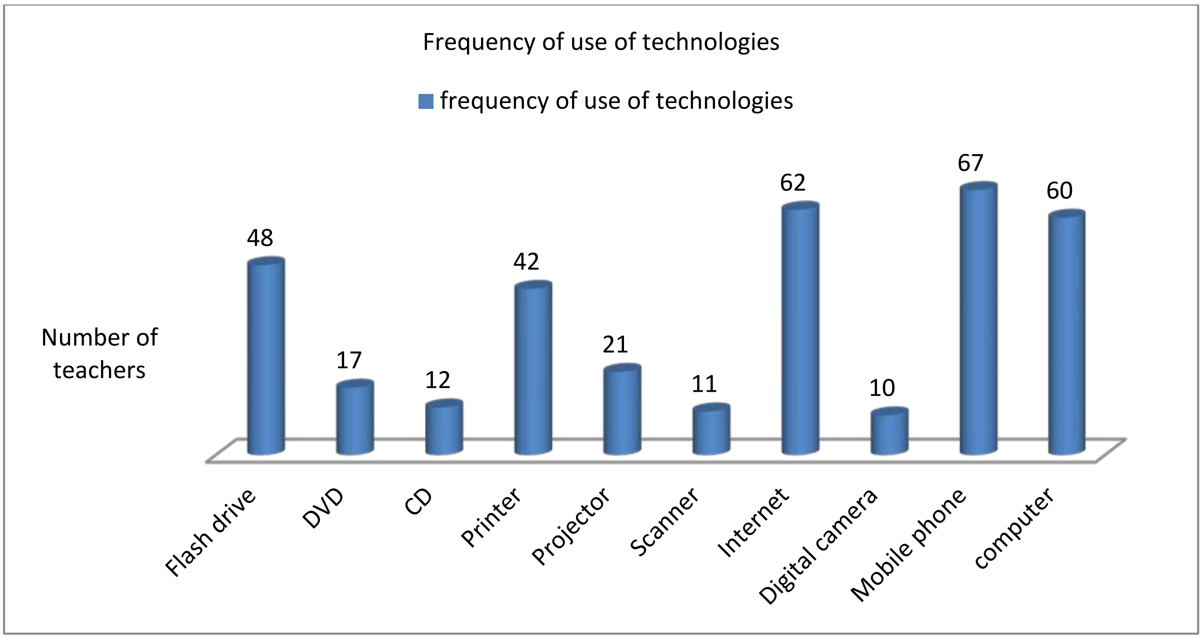

Figure 3: Frequency of the use of technologies by teachers (n = 76 but the teachers chose more than one technology)

Teachers' knowledge

The seven domains of knowledge that we exploredare technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), technological content knowledge (TCK) and technological pedagogical content knowledge (TPACK).

The descriptive statistics (figure 4) indicate that the standard deviation values ranged from 0.0 to 2.0. These results generally demonstrate more similarities than differences within (e.g. among males) and between (e.g. between males and females) the groups of teachers because the standard deviations were low, hence most results are close to the mean. The group of teachers aged 50 and above and those who have taught for 25 years or more, had the highest standard deviations of 1.8 to 2.0 for the types of knowledge which integrate technology, namely TPK, TCK and TPACK (see table 3). This variation is indicative of the fact that some of the teachers in these groups consider themselves technophobic because they had not received formal technological training (Chigona*et al*., 2014).

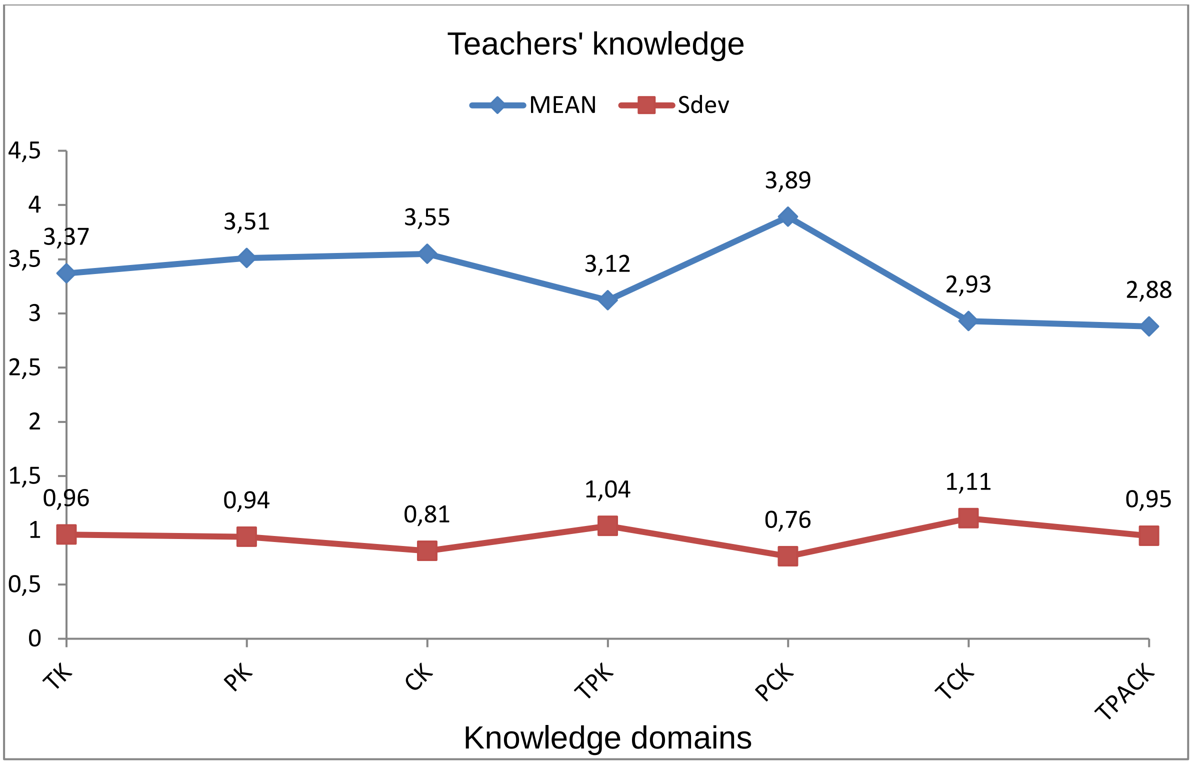

Figure 4: Mean scores and standard deviations for the teachers' domains of knowledge (n = 76)

The mean scores for all domains of knowledge ranged between 2.88 and 3.89 (see figure 4). These scores are above the acceptable level of 3 (average of the Likert points on the questionnaire), except for the scores of TCK (M = 2.93) and TPACK (M = 2.88). The mean scores for CK and PCK range between 3.3 and 4.3 (alsosee table 3), and hence were above the acceptable level of 3 for all the groups of teachers. This means that most of the teachers had more than the moderate level (Likert point 3) of CK and PCK. The mean score for PCK was the highest at 3.89 and the mean score for TPACK was the lowest at 2.88 (see figure 4). The high score for PCK and the low score for TPACK are similar to Messina and Tabone's (2012) findings.

The PCK mean scores for various groups of teachers ranged between 3.74 and 4.25 (table 3) and they were the highest. This shows that teachers had more PCK compared to the other types of knowledge. This is rather surprising because the teachers had to master content and pedagogy as the fundamental domains of knowledge before they could learn to integrate them (Ndongfack, 2015). The fact that PCK, CK and PK had the highest means (3.89, 3.55 and 3.51 respectively) as shown in figure 4 indicates that teachers' professional development programmes probably focussed on content and pedagogy without integrating technology (Barujel*et al*., 2013).

Table 3: Descriptive statistics for the mean of teachers' knowledge domains by gender, age, years of experience, type of school and location of school

Variable	Group of teachers	TK		PK		CK		TPK		PCK		TCK		TPACK	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
	Female (n=22)	3.2	0.9	3.5	1.2	3.6	1.0	2.9	1.2	4.2	0.7	3.0	1.0	2.7	1.0
	Male (n=49)	3.5	1.1	3.6	0.3	3.5	0.7	3.2	1.0	3.7	0.7	2.8	1.2	2.9	0.9
	20-29 (n=15)	3.9	0.6	3.9	0.7	3.5	0.7	3.2	0.9	3.8	0.7	3.5	1.0	3.2	0.6
	30-39 (n=39)	3.5	1.0	3.6	1.0	3.5	0.9	3.1	1.1	3.8	0.8	2.9	0.9	2.8	0.9
	40-49 (n=13)	2.8	0.8	3.4	1.0	3.8	0.8	3.1	0.7	4.2	0.7	2.6	1.2	2.9	1.0
	50+ (n=6)	3.0	1.3	3.1	1.3	3.4	1.2	2.9	1.8	4.0	0.8	2.8	2.0	2.9	1.8
	0-4 (n=20)	3.6	0.9	3.6	0.8	3.5	0.7	3.2	0.9	3.8	0.7	3.1	1.0	3.1	0.7
	5-14 (n=37)	3.4	1.0	3.6	1.0	3.4	0.8	3.1	1.1	3.8	0.8	3.0	1.1	2.8	0.9
	15-24 (n=11)	3.2	0.9	3.6	1.1	3.9	0.8	3.5	0.8	4.2	0.5	3.0	1.3	3.3	1.1
	25+ (n=4)	2.7	1.5	2.8	1.2	3.6	1.3	2.6	1.9	4.3	0.7	2.4	1.9	2.4	1.8
	Government (n=9)	3.4	0.9	3.4	1.3	3.4	0.9	3.2	0.5	3.9	1.0	3.1	0.7	3.0	0.8
	Church (n=59)	3.4	1.0	3.5	0.9	3.6	0.8	3.1	1.1	3.9	0.7	2.9	1.2	2.9	1.0
	Community (n=5)	3.7	0.6	3.7	0.9	3.6	0.8	2.9	0.6	4.0	0.5	2.6	1.0	3.2	0.7
	Urban lowlands (n=37)	3.5	0.9	3.5	0.9	3.6	0.7	3.2	0.8	3.8	0.8	3.0	0.9	2.9	0.9
	Rural lowlands (n=27)	3.3	1.0	3.4	1.0	3.5	1.0	3.1	1.3	4.0	0.7	3.0	1.3	2.9	1.1
	Urban highlands (n=6)	3.2	1.4	3.7	0.7	3.9	0.7	2.9	1.4	3.9	0.8	2.6	1.4	2.7	1.2
	Rural highlands (n=2)	3.9	1.0	3.7	0.5	3.3	0.0	3.5	0.7	4.0	0.9	4.0	1.4	3.8	0.7

The results in table 3 also show that TK had a mean score of 3.37 while the mean scores for TPK, TCK and TPACK were 3.12, 2.93 and 2.88, respectively. TK had a higher mean than the types of knowledge that require integration of technology i.e. TPK, TCK and TPACK. This means that teacher education programmes may have focussed more on technology itself than on the integration of the technologies (Koehler *et al*., 2013). All groups of teachers had means above the acceptable level of 3 for TK, with the exception of teachers aged 40 and above (2.8) and those who had worked for 25 years and more (2.7). This suggests that most teachers have acquired satisfactory levels of technological training, either through pre-service or in-service education. It also suggests that the groups of teachers with a higher age and more teaching experience were trained before technologies were integrated into higher learning because technology is a relatively new phenomenon in developing countries (Khan, 2014). The mean scores for TCK and TPACK were higher forrural schools than for schools in urban areas, the feature that disputes Kalanda and De Villiers' (2013) claim that rural school teachers in Lesotho lag behind in terms of integrating ICTs.

ANOVA for the hypothesis

The p-values varied from 0.0130 to 0.9358 (table 4). The p-values for most domains of knowledge (33 out of 35) of teachers were above the significance level which was set at $\alpha = 0.05$ for this paper (Bhattacherjee, 2012). These p-values show that there was a greater possibility that the findings obtained were a result of random variation (Gelman, 2013). This means that we do not have sufficient evidence in this paper to reject the null hypothesis that high school teachers in Lesotho do not have the types of knowledge required for the integration of a variety of ICTs in their teaching. Therefore, the implication is that there were no significant differences between different variables and various groups of teachers (Aslan & Zhu, 2016). However, two of the 35 values are below 0.05. These are the TK_{age} ($p = 0.013$) and PCK_{gender} ($p = 0.0218$).

Table 4: P-values for teachers' knowledge domains

Domain of knowledge	Probability values (p-values)				
	Age	Gender	Experience	School type	School location
TK	0.0130	0.1766	0.2942	0.7107	0.7363
PK	0.5337	0.3785	0.5226	0.9156	0.8778
CK	0.7517	0.4946	0.4886	0.7999	0.7009
TPK	0.9358	0.2452	0.4854	0.8792	0.9194
PCK	0.2795	0.0218	0.2207	0.9135	0.8925
TCK	0.1765	0.5489	0.6834	0.7080	0.4978
TPACK	0.4624	0.3530	0.2253	0.7478	0.5447

These p-values indicate a significant variation between the TK mean scores of different age groups of the teachers and between males and females in terms of their PCK (Greenland *et al*., 2016; Greenland & Poole, 2011). The PCK mean scores for males (M = 3.7) and for females (M = 4.2) are both above the acceptable level, as a result they may not be a point of major concern. However, the TK mean scores for teachers aged 40 and above require great levels of consideration.This is because they are below the acceptable level.

Conclusions and recommendations

In summary, the data in this study seems to indicate that manyphysical science teachers in Lesotho high schools under study use ICTs for teaching and non-teaching activities, even though they use them irregularly. Their use of ICTs for out-of-classroom activities is slightly higher than their use of ICTs for classroom activities. However, the teachers' ability to integrate technological knowledge into other types of knowledge is not enough to sustain effective implementation of the new physical science curriculum, which demands the integration of ICTs. On average, the teachers have low TPACK even though all groups of teachers have sufficient TK. The teachers who have recently joined the profession as well as the younger teachers, appear tohave more TPACK than the teachers with many years of teaching experience and the more elderly teachers. Teachers from schools in the rural areas also have more TPACK than those in the urban areas, both in the lowlands and the highlands. This information is important because it can be used as a guide for the in-service providers to identify teachers who need more training and supportinstead of going with the common but unfounded assumption that rural teachers need more workshops on ICTs. The information can also help the teacher education institutions to identify the types of knowledge that need to be given more attention. Measuring education and the use ofrelated ICTs are important because the amount of training depends on the level of technological application in a country (Du Toit, 2015). The lack of ICT assessment can lead to provision of far less training than is demanded in a particular country.

Mobile phones, computers and the Internet are among the ICT resources that are used at a higherpercentage. Mobile phones provide teachers with the cheaper and more accessible means of surfing the Internet. Mobile networks have increased Lesotho's telephone density from 1% to 96% in the past 16 years (Morgan-Jarvis, 2015) and the education system has to take advantage of this fact by promoting the integration of ICTs – especially mobile phones – into the curriculum. Flash drives and printers are also used in moderation for storing data and producing hard copies of the information. This paper has highlighted the technologies that are widely used so that they can be promoted. Further research is neededto look deeper into the reasons for the lack of use of other ICT resources such as the scanners and projectors.

The findings of the present study should be handled cautiously because of a few limitations. Firstly, this study followed a survey design which is characterised by a low response rate. This means the size of the final sample was much smaller than the anticipated size. Secondly, clusters (schools) were sampled rather than the individual teachers. This may have significantly affected the characteristics of the sample representation of the population of the Lesotho physical science teachers in question. However, the study is arguably rendered resourceful, with valid findings, given that the sample was representative enough of the teachersin the country. The study area covering five of the ten districts of Lesotho as well as all major geographical areas also helped to overcome any possible sample bias.

This paper attempted to cover a wider population of teachers for more ideas and providing a basis for further research by performing a quantitative survey. The paper also contributed to the regularisation of research by examining the current cohort of teachers. We therefore recommend that more research should be undertakento examine how the use of mobile phones can be adopted in schools as the mobile network coverage increases in the country. Bodies such as the curriculum development centre, the in-service providers and the teacher training institutions can also use the findings of this study to improve their programmes or to form the basis for their own research.

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ARTICLE 2

Teachers' concerns on the integration of information and communication technologies into physical science in Lesotho

Abstract

Change is a gradual process that is affected by the individual's abilities and feelings related to the innovation. The proposed change to the high school physical science curriculum in Lesotho – viz.the integration of information and communication technologies (ICTs) into the subject – depends on teachers' feelings and abilities that manifest as concerns. The purpose of this paper is to investigate the concerns of teachers in selected Lesotho schools with regard to the integration of ICTs into the teaching of physical science. Data were collected from a random cluster sample using the stages of concern questionnaire with an 8-point Likert scale. Statistical analysis software (SAS) was employed to analyse the quantitative data collected to get the descriptive results and the ANOVA of the hypothesis. The results indicate that the percentile score for the informational self-concerns was the highest at 87.5. This demonstrates that the stage 1 concerns are the most intense which implies that the teachers mostly wanted to know more about ICT integration. However, most of the probability values were above the maximum level risk value of 0.05, which indicates that there were no significant differences between the various groups of teachers. These p-values also demonstrate that the mean scores for the stages of concern were more likely to be a result of random chance. We therefore concluded that the physical science teachers in Lesotho mostly have informational concerns related to the integration of ICTs into the curriculum, regardless of their age, gender, type or location of school. This implies that the physical science teachers require ongoing in-service support to provide them with more information in the form of the available ICT resources and their potential to improve teaching.

***Keywords**: ICT integration, CBAM, teachers' concerns, stages of concerns questionnaire, physical science*

Introduction

The techno-orientated life of the 21st century has given rise to learnerswho are quite complex, requiringto be taught by teachers who are competent in the use of technology (Dass, 2014; Duta & Martinez-Rivera, 2015; Irvine, Code& Richards, 2013). The link between significant educational transformation and ICTs has already been established in developed countries but there is less information related to the relationship between education and technology in developing countries (Shahmir*et al.,* 2010). Several developing countries are therefore embarking on the introduction of information and communication technologies (ICTs) into the education system. This is because technology is arguably the best way of obligating schools to encourage learners to apply the potential of ICTs in their own learning as well as in their future places of employment (Hosman&Cvetanoska, 2013; Montelongo& Herter, 2010). ICTs have the potential to improve the quality of education in a variety of ways without any limits of time and space (Alkahtani, 2016; Wan, 2014). This paper consequently argues that education has to take advantage of this context with the guidance obtained from research studies such as this one.

Research indicates that the use of ICTs for teaching is restricted (Buabeng-Andoh, 2012; Gur &Karamete, 2015; Peralta & Costa, 2007). This includes schools where the necessary ICT resources are available (Chigona, Chigona&Davids, 2014). The majority of teachers use ICTs in a limited manner even though they are positive regarding the ability of ICT infrastructure and training to improve instructional activities (Aslan & Zhu, 2016; Buabeng-Andoh, 2012; Mulwa*et al.,* 2012; Zehra&Bilwani, 2016). It therefore does not come as a surprise that some writers believe that ICT infrastructure and training will not necessarily result in the actual usage of ICTs (Agyei 2013; Farrell, Isaacs& Trucano, 2007; Hosman&Cvetanoska, 2013). These writers declare that insufficient planning for ICT integration into the curriculum, among other problems, is the main reason for teachers making limited choices regarding the integration of ICTs. The use and integration of the more complex varieties of ICTs are particularly low in developing countries (UNESCO, 2014). These forms of ICTs have quickly evolving digital characteristics that cause their use to be more complicated because many teachers experienced a different level of technological training than the training offered in this era (Koehler, Mishra&

Cain, 2013; Zehra&Bilwani, 2016). It is consequently imperative to investigate the specific concerns of teachers on aregular basis to enable proper support for the ICT-based curriculum to be implemented as intended.

There are many barriers to ICT integration put forward by teachers according to the literature. These include among others, a lack of time, a lack of equipment,incompetence and/or a lack confidence among teachers and poor organisation (Alkahtani, 2016; Prasad, Lalitha&Strikar, 2015; Unal&Ozturk, 2012). Sometimes the lack of integration of ICTs results from a shortage of technological skills among learners, especially those who come from schools in the rural areas (Wilson-Strydom, Thompson& Hodgkinson-Williams, 2005). Teachers' lack of control over computer laboratories can also be a contributing factor towards the lack of ICT integration. This is particularly true for schools where computers are managed by external funding bodies. For instance, the Khanya project in the Western Cape in South Africa was perceived to be controlling the subjects that could use the computer laboratory and the time that each subject could use it for (Chigona*et al.*, 2014).It is then crucial to comprehend teachers' concerns related to the lack of ICT integration.

A few studies have been conducted in Lesotho on the integration of ICTs even though there are some existing gaps. On the one hand, there is a gap in terms of the focus. For instance, Chere-Masopha (2011) focused on secondary level teachers with no focus onphysical science teachers. Olatokun and Ntemana (2015) studied ICT integration by university lecturers of all subjects (and nothing onhigh school level science). On the other hand, there is a methodological gap regarding research on ICT integration in Lesotho. For instance, Kalanda and De Villiers (2013) approached their study through a participatory action research design while Ntoi (2007) conducted a case study. The current article consequently undertook a quantitative survey study on the subject of ICT integration in an attempt to close the gapas well as to provide some additional information to guide the implementation process onthe integration of ICTs.

The current paper presents the concerns of the Lesotho physical science teachers regarding ICT integration into teaching. Specifically, weexamine the teachers' stages of concern in terms of the connection between personal features and the adjustment of concerns. This is primarily because teachers' concerns can significantly influence their integration of ICTs. Another reason is that the findings from such investigations may be used to solicit individualised as well as contextualised assistance to teachers at different stages of concern (Centikaya, 2012).This paper therefore tests the null hypothesisthat high school teachers in Lesotho do not have significant concerns regarding the integration and use of ICTs for teaching physical science.

Background of the study

ICT integration is a matter of policy implementation because the Lesotho national ICT policy demands that ICTs be incorporated into the core curriculum. Schools and other institutions of learning have been earmarked by the government as some of the main role-players in the implementation of the national ICT policy (Lesotho government, 2005). The ICT policy provides guidance to all stakeholders regarding the provision and use of technology in the country. One of the aims of the national vision 2020 statement, which is the foundation of the ICT policy, includes ensuring a sound foundation for technology research and development in the country. This aim emphasises the need for a strong link between science education and technology education (Lesotho government, 2002). We therefore explored the teachers' concerns regarding their integration of the two subjects: technology and physical science.

Lesotho introduced computer education as a subject taught at junior certificate level (JC) through the National Curriculum Development Centre (NCDC) in 2004 because of the vision and the policy statements on ICTs. The main aim of this endeavour was to provide learners with basic literacy in computers (NCDC, 2004). Lesotho has also recently embarked on a localisation process through its school examining body, namely the Examinations Council of Lesotho (ECoL). The localisation process involves the adaptation of the International General Certificate of Secondary Education (IGCSE) curriculum into the Lesotho General Certificate of Secondary Education (LGCSE), which is the Lesotho version of the same curriculum. The physical science syllabus, which forms part of the LGCSE curriculum, is the focus of this paper because it is relatively new in the country. The physical science examination syllabus demands learners' acquisition of technological and communication skills as they learn the content knowledge (ECoL, 2012). This paper explores the concerns of the teachers related to how they respond to this call of the LGCSE curriculum for the integration of technology into their teaching of physical science.

Lesotho as a country experiences a low rate of integration of ICTs (Kalanda& De Villiers, 2013).In one of the pilot schools for the existing study, for instance, it did not seem as if ICTs were used efficiently. According to my understanding, the school has had a computer laboratory for more than a decade and all of the staff members, including the management and the teachers had received basic computer training under the auspices of School-Net Lesotho but the computers were solely used for teaching computer studies(personal communication, 2016). Teachers did not use the computers to teach the rest of the curriculum or even for administrative and planning purposes. Although the curriculum expects the physical science teachers to use ICTs when they deliver the content knowledge to the learners, there is no clear guidance regarding how this expectation should be implemented. Physical science teachers who were trained using traditional methods of teaching may thusnot feel competent and confident enough to use ICTs for teaching (Messina &Tabone, 2012). However, these teachers may try to use ICTs for other aspects of their profession, such as planning and reporting.

Lesotho's infrastructure and accessibility to ICTs are quite poor(Farrell *et al.*, 2007; UNESCO, 2016). The most underdeveloped aspect of the infrastructure is broadcasting, with only onetelevision station in the country and a few radio stations.The most advanced aspect of infrastructure is cellular connectivity. Cell phone services have increased the telephone mass in Lesotho from 1% to 96% between 2000 and 2015.Thishas made cellular data services and Internet costs more accessible to more people (Morgan-Jarvis, 2015).This means that the physical science teachers need to take advantage of the modern technologies that are brought by smart phones and integrate them into the curriculum.

Literature review and theoretical framework

Teachers require an understanding of policies, principles, contextual factors and cognitive characters, namely knowledge, beliefs and attitudes, to guide them in their work (Cohen, 1990; Spillane, 1999). Spillane, Reiser and Reimer (2002), emphasise that the policies that introduce reforms have to provide teachers with competence to evaluate innovations to do the necessary refinements. The innovation needs to be evaluated in terms of its factors of adherence, quantity and quality (Adomi&Kpangbam, 2010; Brandon *et al.,* 2008). It is also of utmost importance to understand teachers' personal attributes and the motivational factors that influence those attributes when introducing ICTs in schools (Chigona*et al*., 2014).

The teachers' knowledge base is what Shulman (1987) first conceptualised as the pedagogical content knowledge consisting of curricula, assessment processes, institutions, regulations, duties and social change. Mishra and Koehler (2006) then incorporated technology into Shulman's pedagogical content knowledge (PCK) to formulate the technological pedagogical content knowledge (TPACK) framework because of the surfacing of the digital technologies. The type of knowledge that the teachers have influences the way they feel about change.

It follows that teachers' perspectives regarding ICTs considerably affect their acceptance and use of technology in their teaching (Buabeng-Andoh, 2012). Fuller, Parsons and Watkins (1974) refer to these perspectives as concerns by which teachers indicate their requirements. These writers posit that concerns are capable of motivating the teachers' choice of what they want to learn. As a result, the present study is based on the concerns-based adoption model.

The concerns-based adoption model

The concerns-based adoption model (CBAM) was developed by a team of experts, namely Hall, Wallace and Dossett at the University of Texas-Austin in 1973. They built on Fuller's idea of the concerns theory (Centikaya, 2012). CBAM provides us with the means for describing and evaluating the phases of improvement of those learning about an innovation such as ICT integration (Hall, 2010). We explored ICT integration through CBAM because various research-based establishments continue to employ CBAM to promote and facilitate innovations from the personal standpoint (Sultana, 2015; Yidana&Maazure, 2012). For instance, it has been employed as the theoretical foundation in several studies (Dunn, Airola& Garrison, 2013; Hosman&Cvetanoska 2013).

Hall and Hord (2011) regard CBAM as a substantiated creation, which has instruments that have the potential to be used for assessing the extent to which an entity in the form of a person, school and/or district has advanced into the implementation process. They believe that it is essential to comprehend the individual aspect of the implementation process toavoid a situation whereby an innovation is resisted or rejected. This means that CBAM viewschange as a process rather than a once-off occasion, which transpires gradually and through different phases determined by one's abilities, insights, doubts, obsessions, feelings and times of contentment related to the innovation. This indicates that change of the institutions is a consequence of changed members within the institutions (Loucks-Horsley, 1996). Most importantly, CBAM warns us against the presupposition that use of an innovation is only two-fold (use and non-use) but argues that it is a multifaceted endeavour that occurs over time (Hall, 2010).

The demand for the teachers to integrate ICTs into the instruction of physical science necessitates the exploration of their concerns as the implementation process begins so that it can be followed up in due course as they learn, hence, changing their stages of concern. It is crucial to be conscious of the concerns to enable the authorities to adapt support to the teachers' requirements (Holloway, 2003).

The following table gives a summary of the stages of concern (SoC):

Table 2: Stages of concern (Adapted from George, Hall&Stiegelbauer, 2006:4)

Type of concern	Stage of concern	Expression of concern
	6. Refocusing	I know of an alternative that has more potential than ICT integration.
	5. Collaboration	I want to know more about how I can link my integration of ICTs to that of my colleagues.
	4. Consequence	I am anxious about how my integration of ICTs influences my students.
Task concerns	3. Management	I worry about the amount of time it takes me to learn about the new technologies.
	2. Personal	I need to know how integrating ICTs will affect my work.
	1.Informational	I would like to find out more information about ICT integration.
Unconcerned	0.Awareness	I do not know anything about ICT integration.

Methodology

Research approach, paradigm, design and process

The present study followed the quantitative approach and the deductive paradigm that is guided by post-positivism. It also applied the descriptive non-experimental survey design. The advantage of post-positivism is that it allowsone to be objective, logical and systematic when testing the hypothesis while the descriptive non-experimental survey design enabled a researcher to concentrate on the purpose of the study (Mulwa*et al.*, 2012).The non-experimental survey design also allowed for a large population of teachers to be explored in this study by examining only a sample because it is flexible and adaptable. This design further enabledthe description of ICT integration to be tabled without changing the school contexts ordiscussing the cause-effect relations between teachers' concerns and their age, gender,teaching experience or location and type of school (Johnson & Christensen, 2014).This study was an applied research specifically designed to allow the characteristics of ICT integration for the current group of physical science teachers to be understood (Takona, 2002).

Sample and sampling techniques

StatTrek table of random numbers was usedto select a cluster sampleof 23 schools comprising of a total of 76 physical science teachers (StatTrek, 2016). The study was conducted in 50% of the districts of Lesotho, namely Mafeteng, Maseru, Berea, Leribe and Mokhotlong. These districts provided a fair representation of the entire population of teachers from 138 high schools in terms of their demographics, particularly the geographical area or school location that may affect availability of technological resources and knowledge as they consist of the highlands and the lowlands.

The use of a random samplewas chosen for its potential to produce the results that have the accuracy, efficiency, validity and reliability required for generalising the conclusions of the study to the entire population (Mathers, Fox&Hunn, 2009). Therandom sampling technique minimised research costs and time while still ensuring reasonable representation of the population (Creswell, 2013). The cluster method was employed because the individual physical science teachers were located in geographically separated places that would otherwise be quite difficult to reach. The cluster method of the one-stage basic type was preferred because each school had only few physical science teachers. Consequently, all the physical science teachers in the sampled schools were asked to participate in the study.

Data collection and analysis

The respondents filled in a written questionnaire consisting of 21 close-ended items. The data collected from the questionnaire included respondents' demographic details and concerns regarding the use of technologies. All items were based on CBAM's stages of concern questionnaire (SoCQ) and they had an8-point Likert scale of responses. Weightings of the answers on the questionnaire ranged from 0=Irrelevant to 7=Very true of me now. The questionnaires were personally delivered to the selected schools and then gathered as soon as they had been completed.

However some questionnaires were never filled and there were also a few which were not answered fully. Therefore the last Likert point 11 = no response had to be added for reasons of feeding the results into the analysis programme.

Frequencies and the corresponding percentages of the responses to the biographical questions were calculated using the statistical analysis software (SAS) procedure frequency (SAS, 2013). This software seems to be widely used in recent years, particularly in research related to ICT integration (Alkahtani, 2016). Description statistics were calculated for the mean scores for the entire sample (All) and by gender, age, teaching experience as well as type and location of school. This was achieved through the SAS procedure TABULATE (SAS, 2013).

The respondents were grouped into various categories for the biographical variable in question because all the biographical variables were categorical. The mean for the different domains (stages of concern) of the demographic groups was contrasted through one-way analysis of variance (ANOVA) using the SAS procedure general linear model (SAS, 2013). The sum score in question was the dependent variable whereas the stipulated biographical variable was the single factor in the ANOVA model.

Ethical considerations

The Faculty of Education at the University of the Free Stategranted the ethical clearance for this study to be undertaken. The Lesotho Ministry of Education and Training and the school principals were requested in writing to permit the researcher to involve teachers in the study. Participation was strictly voluntary (Leedy&Ormrod, 2005). The willing respondents were asked to complete a consent form that emphasised the significance of the study and potential risks as well as their right to participate in the study and to refrain from participation at any time. The study avoided to expose the respondents to any possible harm. Privacy and confidentiality were observed using numbers on the research instruments as a form of identification and keeping all the completed questionnaire forms in a safe place (Johnson &Christensen, 2014). All the relevant information regarding the purpose of the studywas declared to accomplishhonesty.

Reliability and validity

A pilot study was conducted to enable possible shortcomings in the research design and instrument to be identified. The sample for the pilot study consisted of ten teachers from the nearby schools. This facilitated the adjustment of the items and the procedures followed when administering the instrument in order to have a high response rate and reduce the likelihood of erroneous answers. For instance, some statements were made to be shorter and simpler and the forms were collected upfront from the teachers who opted to fill them immediately. These corrections enhanced the reliability and validity of the study. Some of the confounding variables of the study, such as teachers' age, gender, teaching experience as well as the type and location of school were explored in terms of their effect on the teachers' concerns. This improved the internal validity of the study while the external validity was increased by ensuring a randomised selection of the sample (Bhattacherjee, 2012).

Results and discussions

The stages of concern which will be discussed are stage 0 (awareness), stage 1 (informational), stage 2 (personal), stage 3 (management), stage 4 (consequence), stage 5 (collaboration) and stage 6 (refocusing).

Demographic results

Table 2 shows the demographic details of the sample. The number of males (49 out of 71) was higher than that of females. The following groups of teachers were also larger than the rest of the groups within the same variable; teachers aged between 30 and 39 (39 of 73), teachers with 5 to 14 years of experience (37 of 72), teachers from church schools (59 of 73) and teachers from schools in the urban lowlands of the country (37 of 72). The totals of teachers in various categories differ because some of the teachers did not answer some of the questions about their demographic information.

Table 3: Teachers' demographic data (n = 76)

	Group	Frequency	Percentage
Age (Missing = 3)	20-29	15	20.55
	30-39	39	53.42
	40-49	13	17.81
	50+	6	8.22
	Male	49	69.01
	Female	22	30.99
	0-4 yrs	20	27.78
	5-14 yrs	37	51.39
	15-24 yrs	11	15.28
	25+ yrs	4	5.56
	Government	9	12.33
	Church	59	80.82
	Community	5	6.85
	Lowlands urban	37	51.39
	Lowlands rural	27	37.5
	Highlands urban	6	8.33
	Highlands rural	2	2.78

Teachers' stages of concern

The percentile scores for the stages of concern for all the teachers in the sample are 12.5, 87.5, 50, 25, 62.5, 75 and 37.5 for stages 0, 1, 2, 3, 4, 5 and 6 respectively (see figure 1). These show that the percentile score for stage 1 is the highest at 87.5, whereas the percentile score for stage 0 is the lowest at 12.5.The percentile score for stage 5 is the second highest at 75. The graphical display of the percentile scores in figure 1consequentlydepicts two peaks: one around stage 1 and the other around stage 5. The most intense concerns are therefore the informational (stage 1) and the collaboration (stage 5) concerns, as it was the case in some other studies (Centikaya, 2012; George *et al*., 2006; Lopez & Wise, 2014; Majid, 2011). Teachers with more years of experience with an innovation typically indicate high collaboration concerns (stage 5). In the case of Lesotho, these may be the teachers who started using ICTs even before the new curriculum was introduced or when it began in 2012

(George*et al*., 2006) hence the experience with ICT integration. Teachers who do not use ICTs, or those who are at the beginning stages of using them, are expected to have high informational concerns (Hall *etal*., 1991). As a result, the sample consisted mainly of teachers who probably did not start the use of ICTs back in 2012 due to a variety of reasons that require further investigation. More teachers were at stage 1 seeking information about ICTs because they may have just recently begun to use the ICTs.

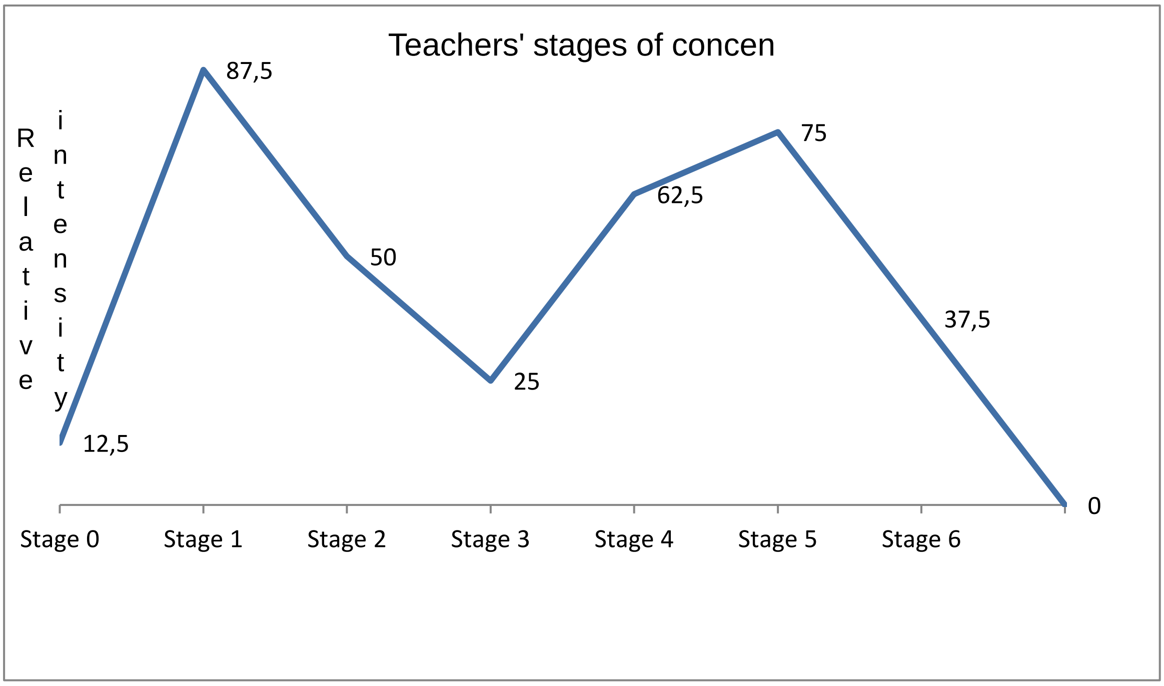

Figure 1: Overall percentile scores for stages of concerns

The fact that the percentile score for stage 0 is the lowest is indicative that only a few teachers are at the point where they are not concerned about ICT integration. Hall and Hord (2011) emphasise that many respondents will not be concerned about any reform initiative that is only starting. Therefore, it makes sense that many teachers are aware of the innovation of ICT integration because it commenced back in 2012, which means that the teachers in the sample have concerns because they have been in the system of an ICT-based physical science curriculum for the past four years.

The percentile score for stage 6 which is 37.5 (see figure 1) is lower than the score for stage 5 (75). This difference caused the graph to taper downwards. This usually means that the teachers are uninformed of any other innovations that work better than ICT integration (Hall *et al*., 1991). The implication is that the teachers believe in the potential of ICTs to improve their teaching.

The stage 1 overall mean scores for teachers aged 50 and above is M=6.1, teachers from government schools, M=6.1 and community schools, M=6.3 while teachers who come from schools in the highlands, $M=6.6_{\text{urban schools}}$ and $M=6.2_{\text{rural schools}}$. This is interesting because these scores are higher than the overall mean score for stage 1 (M = 5.69). These groups of teachers seem to have the highest levels of self-informational concerns. This means that these teachers have more intense needs for knowing about ICT integration than the rest of the sample. These include teachers aged 50 regardless of their gender, experience or type and location of their schools, all the groups of teachers from government and community schools as well as all the groups of teachers working in the highlands. This probably arises from the professional development of teachers aged 50 upwards, which did not include ICT integration or provided a different level of technological training from what they are expected to use today (Du Toit, 2015; Khan & Hasan, 2013; Koehler *et al*., 2013). The concern may also be related to the availability of ICT resources for the government, community and highland schools.

Table 3 shows the stage 5mean scores as M=5.0 for male teachers, M=5.1 for teachers aged 39 years of age and younger, M=5.1 for teachers with 14 and less years of experience, M=5.2 for teachers from government and community schools and M=5.4for teachers from the highlands. It is also interesting to note that these groups of teachers have mean scores for collaboration concerns higher than the overall mean score for this stage, M = 4.9. Stage 5 is also the second highest of all the stages of concern. This means that the male teachers, younger teachers, less experienced teachers, teachers working in government and community schools as well as those teachers working in the highlands have the highest intensity of impact collaboration concerns. The fact that most teachers' concerns are high, at stage 5 and at stage 1, is an indication that the Lesotho physical science teachers are concerned about the possibility of learning from each other with regard to how best they can integrate ICTs into their teaching (Hall, George& Rutherford, 1977). They want to discover challenges by cooperating with and in supporting each other by interacting with each other to create solutions to their problems whilst developing better understanding of ICT integration (Shu, 2016). The female teachers, more elderly teachers and teachers working in church schools seem to beless concerned about collaborating and cooperating in terms of ICT integration.

The results in table 3 show standard deviations ranging from 0.3 to 3.1. Most of the standard deviations are relatively low, thus signalling non-significant differences within the groups of teachers. However, the group of teachers with 25 or more years of teaching experience shows the biggest variations because they have the highest standard deviations for stage 1(1.4), stage 2 (2.8), stage 4 (3.1), stage 5 (2.9) and stage 6 (3.1). This group has varying intensities of concerns because they have different experiences regarding ICT training. Some of them have obtained some technological skills from teacher workshops and self-training initiatives (Khan, 2014).

Table 3: Descriptive statistics for the mean of teachers' stages of concern by gender, age and years of experience

Variable	Group of teachers	Stage 0		Stage 1		Stage 2		Stage 3		Stage 4		Stage 5		Stage 6	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
	Female (n=22)	2.3	1.1	5.7	1.1	4.8	1.2	4.2	1.5	5.1	1.5	5.0	1.5	4.9	0.9
	Male (n=49)	2.3	1.5	5.6	1.2	4.3	1.4	3.6	1.3	4.5	1.4	4.8	1.5	4.0	1.4
	20-29 (n=15)	1.7	1.0	5.8	1.0	4.6	0.9	3.7	1.2	3.9	1.4	5.3	1.1	4.1	1.4
	30-39 (n=39)	2.4	1.4	5.6	1.3	4.6	1.3	3.8	1.5	4.8	1.4	4.9	1.4	4.4	1.2
	40-49 (n=13)	2.3	1.2	5.7	1.1	4.4	1.1	4.3	1.4	5.2	1.0	4.6	1.4	4.6	0.9
	50+ (n=6)	2.9	2.3	6.1	0.7	3.2	2.5	3.3	1.7	4.5	2.6	4.2	2.8	3.3	2.4
	0-4 (n=20)	2.4	1.5	5.9	1.0	4.7	1.0	4.0	1.4	4.4	1.1	5.2	1.0	4.3	1.3
	5-14 (n=37)	2.4	1.5	5.6	1.3	4.5	1.4	3.7	1.4	4.6	1.6	4.9	1.6	4.2	1.2
	15-24 (n=11)	2.1	1.4	5.9	0.9	4.2	1.2	3.8	1.6	5.2	0.9	4.3	1.3	4.5	0.9
	25+ (n=4)	3.0	0.5	5.4	1.4	4.2	2.8	4.0	1.7	4.3	3.1	4.1	2.9	3.4	3.1
	Government (n=9)	2.0	1.7	6.1	0.9	4.7	1.4	4.5	2.2	6.0	1.0	5.4	1.3	5.0	1.0
	Church (n=59)	2.3	1.3	5.6	1.2	4.5	1.3	3.7	1.3	4.5	1.3	4.8	1.4	4.2	1.2
	Community (n=5)	2.5	2.6	6.3	0.8	4.0	2.1	3.7	0.9	3.8	2.3	5.1	2.3	3.5	2.3
	Urban lowlands (n=37)	2.1	1.2	5.6	1.0	4.4	1.2	3.8	1.5	4.6	1.5	4.7	1.4	4.2	1.3
	Rural lowlands (n=27)	2.6	1.5	5.7	1.4	4.4	1.7	3.6	1.4	4.5	1.6	4.8	1.8	4.0	1.5
	Urban highlands (n=6)	1.9	1.3	6.6	0.5	4.6	0.7	4.6	0.8	4.6	0.7	5.6	0.8	4.8	0.3
	Rural highlands (n=2)	3.5	3.1	6.2	0.2	5.3	0.5	5.5	0.7	5.3	0.5	5.2	0.7	5.8	0.7

Reliability

The Cronbach alpha coefficients of internal reliability for the stages of concern were 0.63_{S0},0.62_{S1}, 0.43_{S2}, 0.34_{S3}, 0.55_{S4}, 0.68_{S5} and 0.27_{S6}. These values are not comparable with the values obtained by Hall *et al*. (1977) where n=830.In their study, the alpha values ranged from 0.64 to 0.83.However, the coefficients are comparable to the values obtained by George*et al*. (2006) in their validity study where n=40. The sample size here was small and the alpha values ranged from 0.41 to 0.69. The other source of the differences in our values emanates from the fact that 21 items of the stages of concern questionnaire (SoCQ) were used instead of all 35 items of the original instrument. These coefficients show that the items used were nonetheless reliable for measuring teachers' concerns in this study because they were neither above 0.9 nor very close to 0 (Tavakol&Dennick, 2011).

ANOVA for the hypothesis

Most of the p-values (32 out of35)for the stages of concern (table 4) are above the statistical significance level (α) which is taken as 0.05 for most statistical analyses and for this paper (Bhattacherjee, 2012). This means that our numerical data does not substantiate the rejection of the null hypothesis. Consequently, we fail to reject our null hypothesis that high school teachers in Lesotho do not have significant concerns regarding the integration and use of ICTs for teaching physical science.This is indicative of the fact that there was a greater possibility that the most of the findings obtained were a result of random variation (Gelman, 2013). The implication is that there were no significant differences between different variables within the groups of teachers.

Table 4: The p-values for the stages of concern

Stage of concern	Age	Gender	Experience	Type of school	Location of school
0-Awareness	0.2280	0.8826	0.7397	0.7818	0.2685
1-Informational	0.8526	0.7714	0.7178	0.1757	0.2339
2-Personal	0.1111	0.0143	0.7125	0.6726	0.7935
3-Management	0.4532	0.0937	0.8749	0.3111	0.1610
4-Consequence	0.1284	0.1211	0.5422	0.0066	0.9046
5-Collaboration	0.3766	0.7349	0.2720	0.4173	0.6114
6-Refocusing	0.2122	0.0087	0.5629	0.0948	0.2074

The results did not seem to depend on the teachers' age, gender, experience, type and location of school. However, there are three (of 35) p-values below the confidence level, $\alpha = 0.05$. These are the values for gender ($p = 0.0143_{S2}$ and $p = 0.0087_{S6}$) and for type of school (0.0066). These three values demonstrate significant differences between males and females in terms of their stages 2 (personal) and 6 (refocusing) concerns. They also mean that there is a significant variation in the mean scores for government schools (M = 6.0), church schools (M = 4.5) and community schools (M = 3.8) regarding their stage 4 (consequence) concerns (Greenland *et al*., 2016; Greenland & Poole, 2011). The sources of the differences between these groups of teachers may require some consideration from the authorities.

Conclusions and recommendations

In most countries, including Lesotho, it is the government officials, rather than teachers' decision to choose to use various ICT resources in schools (Hall, 2010). An application of the CBAM stages of concern creation in research is an attempt to help those with such decision authority to access teachers' reaction necessary for the planning of future reform initiatives as well as monitoring and evaluating the progress of the implementation process (Hall &Hord, 2011). As Holloway (2003) putsit, the realisation of the teachers' concerns is the gateway to a tailored form of assistance and support towards the implementers of the innovation in question.

The purpose of this article was to establish the physical science teachers' concerns regarding the integration of ICTs into teaching by exploring the variety of stages of concern that they are currently exhibiting. The evidence collected indicates that the teachers experience the entire spectrum of concerns from stage 0 to stage 6. However, the results clearly demonstrate that most teachers have self-informational concerns (stage 1), which are typical of people at an early phase of an innovation. According to George *et al*. (2006), this profile is distinctive for individuals who do not use the newly introduced improvement. However, they also highlight that the fact that these teachers do not have strong self-personal concerns (stage 2) means that they are not opposed to the transformation but have the will to adopt the new curriculum that demands ICT integration. The teachers want to know more about the integration of ICTs into their teaching even though they may not be currently using ICTs for reasons that require thorough research to investigate.

A good number of teachers also reported impact concerns in stages 4 and 5. As Hall *et al*. (1991) have asserted; a profile that peaks around these stages befits teachers with plenty of experience with the innovation. This is highly probable in Lesotho's case because some of the teachers may have been involved with ICT integration since 2012 when the new physical science curriculum was introduced or even before then. These teachers are interested in learning from their colleagues about how best they can integrate ICTs into their teaching. They are also worried about how their use of ICTs might influence their students' learning of the subject.

The results of the present study should be used with caution because the sample used was not large enough to impact major decisions. However, the results areuseful because the sample was representative of most groups of teachers in the country. Caution should also be exercised to avoid using the results and conclusions of the present study as though they were factual because they are only hypotheses and exploratoryand therefore should be viewed as such.

It is recommend that a more thorough study should be undertaken to investigate teachers' needs related to ICT integration. It is important for the concerns of teachers regarding the integration of ICTs into physical science education be interrogated now at the beginning phase of its implementation in order to contribute to the information that may help enhance improvement and more innovative use of ICTs with time. As Sife*et al.* (2007) state, the integration of ICTs in the operation of any institution is complicated and needs to be fully described for all stakeholders to understand as the implementation process commences. It could also enhance the success of future curriculum reforms if classroom teachers were to be incorporated into bodies that are responsible for the development of such reforms (Alkahtani, 2016).

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Section 3: Discussion, conclusion and implications

3.1. Discussion of results

In this final section of the articles-based dissertation, the results of the study are summarised to indicate how and which of the research questions have been addressed by the findings. The results on the use of ICTs are addressed first, followed by the knowledge and concerns of teachers related to the integration of ICTs into the curriculum.

3.2. Teachers' practices regarding the use of ICTs (first research question)

The results in table 2,as discussedin article 1 (p.30), demonstratethat 77% of thesample teachers useICTs for teaching and 80% usethem for non-teaching activities. Most of the teachers therefore reportedlyusedICTs even though they had different reasons for using them. Consequently, their use of ICTs for non-teaching activities was slightly more than their use for teaching purposes.

Article 1 (p.29) has shown the acceptable level of responses for this study as the mean, M = 3 (Nwanekezi*et al*., 2011) for teachers' knowledge and use of ICTs.Themean score, M =2.5 (see table 2 in article 1 p.30) for the use of ICTs for teaching activities was therefore below the acceptable level of 3.As a result, there is a necessity to improve ICT integration into teaching activities in Lesotho. The mean score of 3.4 for non-teaching activitieswas slightly above the acceptable level. These findings indicate that teachers indeed have some technological skills that they employ inside and outside their classrooms even though they use them for other professional commitments more often than they do for teaching.

The standard deviations of 1.08 for teaching activities and 1.15 non-teaching activities (table 2)reveal that in both cases, the results were close to the mean and therefore the two extremes were not common. That is, theteachers seemingly neither used ICTson a daily basis (Likert point 5) nor avoided using them altogether (Likert point 1). These results that show more use of ICTs are in line with the findings by Kalanda and De Villiers (2013) which suggest that the use of ICTs in Lesotho is increasing. However, similar toHaddad, Ferreira andFaria, (2014) we are less excited because the results may be an indication that the teachersare using the technologies to perform their usual traditional dutiesrather than using them to enhance the teaching and learning of physical science *per se*.For instance, they may be using search engines to develop their content knowledge rather than using them in the classroom with their learners.

3.3. The formsof ICTs used (second research question)

The results discussed in article 1 (figure 3 p.31) show the mostly used technologies as mobile phones (67 teachers), the Internet (62 teachers) and computers (60 teachers)(see figure 3**)**. Digital cameras (10 teachers), scanners (11 teachers) and CDs (12 teachers) were among the least used forms of ICTs. The rest of the technologies were used in moderation. Smart phones and computers, which have built-in cameras, may have replaced digital cameras as the more convenient toolsto use. Flash drives may be more popular than CDs and DVDsbecause they are more durable. Mobile phones are also more widely usedto reach the Internet than computersbecause teachers possiblyhave more access to their mobile phones than to the school computers(Mulwa*et al*., 2012).

3.4. Teachers' knowledge (third and fifth research questions)

The seven domains of knowledge discussed are technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), technological content knowledge (TCK) and technological pedagogical content knowledge (TPACK).

Article 1 (see figure 4, p. 32) relayed the mean scores for all domains of knowledge as rangingfrom 2.88 to 3.89. Most of the scores are above the acceptable level of 3 (average of the Likert points which falls on moderate knowledge), except for the scores of TCK (2.93) and TPACK (2.88). The article also shows high mean scores for CK and PCK rangingfrom 3.3 to 4.3 (see table 3, p.34).These were above the acceptable level of 3 for all the groups of teachers, thus revealing that most of the teachers had more than the moderate level of CK and PCKeven though their TCK and TPACK were below the moderate level. PCK was the most common type of knowledge with the highest mean score of 3.89 while TPACK was the least common type of knowledge with the lowest mean of 2.88. Messina and Tabone (2012) also obtained high scores for PCK and low scores for TPACK, so this was to be expected.

The PCK mean scores for various groups of teachers ranged between 3.74 and 4.25 (table 3, p.34) and they were also the highest. This shows that teachers had more PCK than the other types of knowledge regardless of their age, gender, teaching experience or place of work. One would expect the teachers to master content and pedagogy as the fundamental domains of knowledge before they could learn to integrate them, such that they could have higher CK and PK than PCK (Ndongfack, 2015). However, the fact that PCK, CK and PK had the highest means (3.89, 3.55 and 3.51 respectively) shows that teachers' professional development programmes probably focus moreon content and pedagogy, perhapswithout integrating technology (Barujel*et al*., 2013).

The results in table 3 also show that TK had a mean score of 3.37 while the mean scores for TPK, TCK and TPACK were 3.12, 2.93 and 2.88, respectively. TK had a higher mean than the technology-based types of knowledge, namely TPK, TCK and TPACK. This means that teacher education institutions may have focussed more on technology use rather than on its integration into pedagogy (Koehler *et al*., 2013). All groups of teachers had means above the acceptable level of 3 for TK, with the exception of teachers aged 40 and above (2.8) and those who had worked for 25 years and more (2.7). This suggests that the more agedand more experienced teachers were possiblytrained before technologies were integrated into higher learning because technology is a relatively new phenomenon in developing countries (Khan, 2014). Surprisingly,the teachers from rural schools showed higher TCK and TPACK mean scores than their counterparts from urban areas.This feature disputes Kalanda and De Villiers' (2013) claim that rural school teachers in Lesotho lag behind in terms of integrating ICTs.

The descriptive statistics in article 1 (figure 4, p.32) indicate that the range of standard deviations is from 0.0 to 2.0. These low standard deviations generally demonstrate more similarities than differences within and between the groups of teachers because most results are close to the mean. The group of teachers aged 50 and above and those who have taught for 25 years or more, had the highest standard deviations ranging from 1.8 to 2.0 for the ICT-based types of knowledge namely TPK, TCK and TPACK (see table 3 in article 1 p.34). This variation is indicative of the fact that some of the teachers in these groups, particularly those who declared to have no knowledge at all, consider themselves technophobic because they had not received formal technological training (Chigona*et al*., 2014)

3.4.1. **ANOVA for the first null hypothesis**(H_0: High school teachers in Lesotho do not have the types of knowledge required for the integration of a variety of ICTs into their teaching of physical science.)

The p-values ranging from 0.0130 to 0.9358 (article 1 table 4 p.36) for most domains of teachers' knowledge (33 out of 35) were above the significance level, $\alpha = 0.05$. These p-values show that there was a greater possibility that the findings obtained were a result of random variation (Gelman, 2013). This means that the researcher does not have sufficient statistics to reject the null hypothesis that high school teachers in Lesotho do not have the types of knowledge required for the integration of a variety ofICTs in their teaching. Therefore, the implication is that there were no significant differences between different variables and various groups of teachers in terms of knowledge (Aslan & Zhu, 2016). However, two of the 35 values are below 0.05. These are the TK_{age} ($p = 0.013$) and PCK_{gender} ($p = 0.0218$).These p-values indicate a significant variation between the TK mean scores of different age groups of the teachers and also between males and females in terms of their PCK (Greenland & Poole, 2011; Greenland *et al*., 2016). This may be an indication that the sources of the differences in TK of various age groups of teachers as well as the difference in PCK of male and female teachers need to be considered for future reforms.

3.5. Teachers' concerns (fourth and fifth research questions)

The stages of concern discussed are,stage 0 (awareness), stage 1 (informational), stage 2 (personal), stage 3 (management), stage 4 (consequence), stage 5 (collaboration) and stage 6 (refocusing).

In article 2 the researcher displayed the overall percentile scores for stages 0, 1, 2, 3, 4, 5 and 6 as12.5, 87.5, 50, 25, 62.5, 75 and 37.5 respectively (see figure 1, p.58). Thepercentile score for stage 1 is therefore the highest at 87.5, whereas the percentile score for stage 5 is the second highest at 75. The percentile score for stage 0 is the lowest at 12.5. The graphical display of the percentile scores in figure 1consequentlydepicts two peaks: one around stage 1 and the other around stage 5. The most intense concerns are therefore the informational (stage 1) and the collaboration (stage 5) concerns as it was the case in some other studies (George *et al*., 2006; Majid, 2011; Centikaya, 2012; Lopez & Wise, 2014). Teachers with more years of experience with an innovation typically indicate high collaboration concerns (stage 5). In the case of Lesotho, these may be the teachers who started using the ICTs even before the new curriculum was introduced or when it began in 2012 (George*et al*., 2006) hence the experience with ICT integration. Teachers who do not use ICTs, or those who are at the beginning stages of the innovation are expected to have high informational concerns (stage 1). As a result, the sample consisted mainly of teachers who probably did not start the use of ICTs back in 2012 due to a variety of reasons that require further investigation. Thus, more teachers were at stage 1 seeking information about ICTs because they may have just recently begun to use the ICTs.

The fact that the awareness (stage 0)percentile score is the lowestresult is indicative that only a few teachers are at the point where they are not concerned about ICT integration. Hall and Hord (2011) emphasise that many respondents will not be concerned about any reform initiative that has just begun. Therefore, it makes sense that most of the sampled teachers are aware of ICT integration because the innovation commenced in 2012, which means that the teachers in the sample have concerns because they have been in the system of an ICT-based physical science curriculum for the past four years.

The percentile for stage 6 (37.5) is lower than that of stage 5 (75), thus causing the graph to diminish downwards. This usually means that the teachers are unenlightened of any other innovations that may work better than ICT integration (Hall *et al*., 1991). The physical science teachers observed here therefore believe in the potential of ICTs to assist them in their daily instructional endeavours.

Article 2 (table 3, p.61) has already indicated the range of stage 1 mean scores from 6.1 to 6.6 for teachers aged 50 and above (M=6.1), teachers from government schools (M=6.1) and community schools (M=6.3) and teachers who come from schools in the highlands ($M=6.6_{\text{urban schools}}$) and ($M=6.2_{\text{rural schools}}$). This is remarkable because these scores are higher than the overall mean score for stage 1, M = 5.69. This means that these teachers have more intense needs for knowing more about ICT integration than the rest of the sample. All the teachers aged 50 and above have intense informational concerns regardless of their gender, experience or type and location of their schools. This probably arises from their professional development, which conceivablydid not include ICT integration or provided a different level of technological training from what they are expected to implement today (Du Toit, 2015; Khan & Hasan, 2013; Koehler *et al*., 2013). The teachers who work in government and community schools as well as all types of schools in the highlands also have intense stage 1 concerns regardless of their age, gender or teaching experience. These may be related to the distribution of ICT resources among their schools.

Table 3 (p.61)also shows a range of stage 5mean scores from 5.0 to 5.4 formale teachers(M=5.0),for teachers aged 39 years of age and younger (M=5.1), for teachers with 14 and less years of experience (M=5.1), for teachers from government and community schools (M=5.2) and for teachers from the highlands (M=5.4). It is also interesting to note that these groups of teachers have mean scores for collaboration concerns higher than the overall mean score for this stage, M = 4.86. This means that these groups of teachers have the highest intensity of impact collaboration concerns. The fact that the teachers' concerns are high, both at stage 5 and at stage 1, is an indication that the Lesotho physical science teachers are concerned about the possibility of learning from each other with regard to how best they can integrate ICTs into their teaching (Hall *et al.*, 1977). They want to discover challenges by cooperating with and in supporting each other by interacting with each other to create solutions to their problems whilst developing a better understanding of ICT integration (Shu, 2016). However, the teachers who are female, more elderly, more experienced and those who work in church schools and in the lowlands seem to be less concerned about collaborating and cooperation.The source of this lack of concern needs further investigation.

The results in table 3also show standard deviations ranging from 0.3 to 3.1. Most of the standard deviations are relatively low, thus signalling non-significant differences within the groups of teachers. However, the group of teachers with 25 or more years of teaching experience shows the biggest variations because they have the highest standard deviations for stage 1(1.4), stage 2 (2.8), stage 4 (3.1), stage 5 (2.9) and stage 6 (3.1). This group has varying intensities of concerns because they have different experiences regarding ICT training. Some of them are more likely to have obtained some technological skills from teacher workshops and self-training initiatives (Khan, 2014).

3.5.1. ANOVA for the second null hypothesis (H_0: High school teachers in Lesotho do not have significant concerns regarding the integration of ICTs into the teaching of physical science.)

Most of the p-values for the stages of concern (table 4, p.63) are above the statistical significance level ($\alpha = 0.05$). This means that our numerical data does not substantiate the rejection of the null hypothesis. Consequently, we fail to reject our null hypothesis that high school teachers in Lesotho do not have significant concerns regarding the integration and use of ICTs for teaching physical science.

There are 32 (out of35) values which are above 0.05 ($p \geq 0.05$). This is indicative of the fact that there was a greater possibility that most of the findings obtained were a result of random variation (Gelman, 2013). Therefore, the implication was that there were no significant differences between different variables within the groups of teachers. The results did not seem to depend on the teachers' age, gender, experience, type and location of school. However, there are three (of 35) p-values below the confidence level ($p \leq 0.05$). These are the values for gender ($p = 0.0143_{S2}$ and $p = 0.0087_{S6}$) and for type of school ($p = 0.0066$). These three values demonstrate significant differences between males and females in terms of their stages 2 (personal) and 6 (refocusing) concerns. They also mean that there is a significant variation in the mean scores for government schools ($M = 6.0$), church schools ($M = 4.5$) and community schools ($M = 3.8$) regarding their stage 4 (consequence) concerns (Greenland & Poole, 2011; Greenland *et al*., 2016). This implies that the sources of the differences among these groups of teachers require further investigation through future research.

3.6. Conclusions

The aim of the existing study was to establish the practices of high school teachers in Lesotho in terms of their use and integration of ICTs as well as their knowledge and concerns on the same subject. This study shows that many physical science teachers in Lesotho high schools under study use ICTs for teaching and non-teaching activities even though they use them irregularly. Their use of ICTs for out-of-classroom activities is slightly higher than their use of ICTs for classroom activities. However, the teachers' TPACK is not enough to sustain effective implementation of the new physical science curriculum, which demands the integration of ICTs. The teachers who have recently joined the profession as well as the younger teachers, have more TPACK than the teachers with many years of teaching experience and the more mature teachers. Teachers from schools in the rural areas also have more TPACK than those in the urban areas, both in the lowlands and the highlands.This may indicate that the rural teachers may not themselves necessarily have a rural or under privileged background *per se*, as much as that they just happen to fill the available jobs in the rural schools.

Mobile phones, computers and the Internet are among the ICT resources that are used at a high rate. Mobile phones provide teachers witha cheaper and more accessible means of surfing the Internet. Flash drives and printers are also used in moderation for storing data and producing hard copies of the information respectively.

The evidence collected indicates that the teachers experience the entire spectrum of concerns from stage 0 to stage 6. However, the results clearly demonstrate that most teachers have self-informationalconcerns, which are typical of people at an early phase of an innovation. According to George *et al*. (2006), this profile is distinctive for individuals who do not use the newly introduced improvement. However, they also highlight that the fact that these teachers do not have strong self-personal concerns means that they are not opposed to the transformation but have the will to adopt the new curriculum that demands ICT integration. The teachers want to know more about the integration of ICTs into their teaching even though they may not be currently using ICTs for reasons that require further research to investigate.

A good number of teachers also reported impact concerns in stages 4 and 5. As Hall *et al*. (1991) have asserted; a profile that peaks around these stages befits teachers with plenty of experience with the innovation. This is highly probable in Lesotho's case because some of the teachers may have been involved with ICT integration since 2012 when the new physical science curriculum was introduced. These teachers are interested in learning from their colleagues about how best they can integrate ICTs into their teaching. They are also worried about how their use of ICTs might influence their students' learning of the subject.

3.7. Implications

The information about the TPACK is vital because it can be used as a guide for the in-service providers to identify teachers who need more training and support. The teacher education institutions also haveinformation that can help them to identify the types of knowledge that need to be given more attention. It is crucial to evaluateICT knowledge because the amount of training required depends on the level of technological application in each country (Du Toit, 2015).

This dissertation has highlighted the technologies that are widely used so that they can be promoted. For instance, mobile networks have increased Lesotho's telephone density from 1% to 96% in the past 16 years (Morgan-Jarvis, 2015) and the education system has to take advantage of this fact by promoting the integration of ICTs – especially mobile phones and other hand-held devices– into the curriculum. More research needs to be conducted to examine how the use of mobile devices can be adopted in schools. Further research, however,needs to be conducted to look deeper into the reasons for the lack of use of other ICT resources such as scanners and projectors. Curriculum developers, in-service providers and teacher training institutions can also use the findings of this study to improve their programmes or to form a base for their own research.

In most countries, including Lesotho, it is decided by government officials, rather than the teachers to choose to use various ICT resources in schools (Hall, 2010). An application of CBAM in research is an attempt to help those with such decision power to access teachers' feedback necessary for the planning of future reform initiatives as well as for the monitoring and evaluation of the progress of the implementation process (Hall &Hord, 2011). As Holloway (2003) confers, the realisation of the teachers' concerns is the gateway to a tailored form of assistance and support towards the implementers of the innovation in question. It is consequently of momentous importance to regularise and institutionalise research on teachers' concerns regarding the integration and use of ICTs.

It is recommended that a more thorough study should be undertaken to investigate teachers' needs related to ICT integration. It is imperative for the concerns of teachers regarding the integration of ICTs into physical science education to be interrogated now at the beginning phases of its implementation in order to contribute to the information that may help to enhance improvement and more innovative use of ICTs with time. The integration of ICTs in the operation of any institution is complicated and needs to be fully described for all stakeholders to understand as the implementation process commences(Sife*et al.,*2007). It could also enhance the success of future curriculum reforms if classroom teachers were to be incorporated into bodies that are responsible for the development of such reforms (Alkahtani, 2016).This could ensure that the teachers take full responsibility and ownership of such curriculum innovations.

3.8. Limitations

The results of this research project should be handled with caution because of a few limitations. Firstly, this study followed a survey design which is characterised by a low response rate. This means that the size of the final sample was much smaller than the anticipated sizeand hence the sample used was not large enough to impact major decisions. Secondly, clusters (schools) were sampled rather than the individual teachers. This may have significantly affected the characteristics of the sample representation of the population of the Lesotho physical science teachers in question. However, the study is useful, with valid findings, given thatthe sample was representative enough of the teachers. The study area covering five of the ten districts of Lesotho as well as the main groups of teachers and all the major geographical areas and types of schools also helped to overcome any possible sample bias. Caution should also be taken to avoid using the results and conclusions of the present study as though they are factual because they are only hypotheses and therefore should be viewed as such.

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Appendices

Appendix 1: Ethical clearance letter

UFS·UV
EDUCATION
OPVOEDKUNDE

Faculty of Education

25-Nov-2015

Dear Ms **Lucia Nthooa Lisene**

Ethics Clearance: **The Integration of Information and Communication Technologies in the Teaching of Physical Science in Lesotho**

Principal Investigator: **Ms Lucia Nthooa Lisene**

Department: **School of Education Studies (Bloemfontein Campus)**

APPLICATION APPROVED

With reference to you application for ethical clearance with the Faculty of Education, I am pleased to inform you on behalf of the Ethics Board of the faculty that you have been granted ethical clearance for your research.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2015/0633**

This ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the ethics office to ensure we are kept up to date with your progress and any ethical implications that may arise.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours faithfully

Dr. Juliet Romahai
Chairperson: Ethics Committee

Education Ethics Committee
Office of the Dean: Education
T: +27 (051) 401 9683| F: +27 (0)86 546 1113 | E: RamohaiJ@ufs.ac.za
Winkie Direko Building | P.O. Box/Posbus 339 | Bloemfontein 9300 | South Africa
www.ufs.ac.za

Appendix 2: Permission to conduct research from the ministry of education

THE KINGDOM OF LESOTHO
MINISTRY OF EDUCATION AND TRAINING
MASERU DISTRICT EDUCATION OFFICE
P.O. BOX 47. MASERU 100.
22 313 709 / 22 322 755

12 April 2016

The Principal

____
Maseru 100

Dear Sir/Madam

RE: RESEARCH

"THE INTEGRATION AND COMMUNIATIONS TECHNOLOGIES INTO THE TEACHING OF PHYSICAL SCIENCE IN LESOTHO"

MS. LUCIA NTHOOA LISENE is a student who is conducting a research on the above stated topic. She therefore wishes to carry out a research at your school.

You are kindly requested to provide her with the information that she may require.

Thanking you in advance for your usual support.

MASERU DISTRICT
EDUCATION OFFICE
12 APR 2016
P.O. BOX 47, MASERU - LESOTHO
TEL.: 22322755/22313709

Yours Faithfully

Ralibakha

LEPEKOLA RALIBAKHA (MR)
SENIOR EDUCATION OFFICER - MASERU

Appendix 3: Letter to the Ministry of Education and Training

P. O. Box 44

Teyateyaneng 200

The Senior Education Officer

Maseru Education Office

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

Dear Sir/Madam

This letter serves to request permission to conduct research in selected high schools within your district.

My name is Lucia Lisene, and I am currently studying for a master's degree at the University of the Free State. As part of my master's programme, I am required to conduct research on a topic of interest with a purpose of contributing towards knowledge and understanding of the topic under study. The title of my research project is:

The integration of information and communications technologies into the teaching of physical science in Lesotho

The research is aimed at describing the perceptions of physical science teachers regarding the integration of information and communications technologies (ICTs) into teaching and learning activities. The focus of the study is to establish whether or not high school teachers of physical science use ICTs for teaching, and if they do, I would like to know which ICT facilities they are using. I am also interested in exploring the teachers' concerns and knowledge regarding the integration of ICTs into the curriculum. The study has the potential to benefit the teachers who are implementing the physical science curriculum by making them aware of the requirements of the curriculum and by highlighting the ICTs and competences that are being applied by other teachers. The study may also help the curriculum developers, policy makers and teacher educators to incorporate some of the findings into their future plans.

The study will involve a quantitative survey and will require teachers to fill in a questionnaire form. The questionnaire will take them approximately 20-30 minutes to complete during short breaks, lunch time or after school hours at home to avoid class disruption. I undertake to respect confidentiality and privacy of the participating teachers. The participants will not be intentionally exposed to any form of harm during the study. Please note that participation in the study is strictly voluntary and the participants are free to opt out of the study at any time if they so wish.

I undertake to provide the research report to the Ministry of Education and Training once the study has been completed and to share the findings of my research with the physical science teachers and the rest of the teachers at various meetings and conferences.

Attached is the letter of recommendation from my research supervisor regarding my study and progress. If you have any comments or need further clarification, please contact me or my research supervisor, Professor Loyiso Jita at jitalc@ufs.ac.za or +27 51 401 7522.

Thank you for your kind consideration of my request.

Yours sincerely

Lucia Lisene (Phone: 62006923, e-mail: lnlisene@yahoo.com)

Appendix 4: Letter to the principal

P.O. Box 44

Teyateyaneng 200

The School Principal

_______________________ High School

REQUEST FOR PERMISSION TO CONDUCT RESEARCH

Dear Sir/Madam

This letter serves to request permission to conduct research with physical science teachers in your school.

My name is Lucia Lisene, and I am currently studying for a Master's degree at the University of the Free State. As part of my Masters program, I am required to conduct research on a topic of interest with a purpose of contributing towards knowledge and understanding of the topic under study. The title of my research project is:

The integration of information and communications technologies into teaching of physical science in Lesotho

The research is aimed at describing the perceptions of physical science teachers regarding the integration of information and communications technologies (ICTs) into teaching and learning activities. The focus of the study is to establish whether or not high school teachers of physical science use ICTs for teaching, and if they do, I would like to know which ICT facilities they are using. I am also interested in exploring the teachers' concerns and knowledge regarding the integration of ICTs into the curriculum. The study has the potential to benefit the teachers who are implementing the physical science curriculum by making them aware of the requirements of the curriculum and by highlighting the ICTs and competences that are being applied by other teachers. The study may also help the curriculum developers, policy makers and teacher educators to incorporate some of the findings into their future plans, which will also benefit the teachers.

The study will involve a quantitative survey and will require teachers to fill in a questionnaire form. The questionnaire will take them approximately 20-30 minutes to complete during short breaks, lunch time or after school hours at home to avoid class disruption. I undertake to respect confidentiality and privacy of the participating teachers. The participants will not be intentionally exposed to any form of harm during the study. Please note that participation in the study is strictly voluntary and the participants are free to opt out of the study at any time if they so wish.

I undertake to provide the research report to the Ministry of Education and Training once the study has been completed and to share the findings of my research with the physical science teachers and the rest of the teachers at various meetings and conferences.

I have already applied for and received permission from the Ministry of Education and Training to conduct the study. If you have any comments or need further clarification, please contact me or my research supervisor, Professor Loyiso Jita at jitalc@ufs.ac.za or +27 51 401 7522.

Thank you for your kind consideration of my request.

Yours sincerely

Lucia Lisene (contacts: 62006923, lnlisene@yahoo.com)

Appendix 5: Consent form

The physical science teacher

INVITATION TO PARTICIPATE IN A RESEARCH STUDY

Dear Sir/Madam

This letter serves to invite you to participate in a research study.

My name is Lucia Lisene, and I am currently studying for a Master's degree at the University of the Free State. As part of the study program, I am conducting a research project titled:

The integration of information and communications technologies into the teaching of physical science in Lesotho

The purpose of the research study is to understand the concerns and knowledge that physical science teachers have regarding the use of information and communications technologies (ICTs) for teaching and learning.

You have been identified as one of the teachers who are implementing the new physical science curriculum and whose practice of integrating ICTs we can learn from. The study has the potential to benefit you and other teachers who are implementing the physical science curriculum which requires the integration of ICTs, by indicating the ICTs used by other teachers, and the concerns and type of knowledge other teachers have regarding ICT integration.

The study will involve a quantitative survey, and will require you to fill in a questionnaire form. The questionnaire will take you approximately 20-30 minutes to complete during your short break, lunch time or after school hours at home.

Your responses will remain confidential and will be used for research purposes only. Participants will not be intentionally exposed to any form of harm during the study. Please note that participation in the study is voluntary and you are free to opt out of the study at any time if you so wish.

I undertake to provide the research report to the Ministry of Education and Training once the study has been completed and to share the findings of my research with the physical science teachers and the rest of the teachers at various meetings and conferences.

If you agree to participate in the research study titled:

The integration of information and communication technologies into the teaching of physical science in Lesotho,

please complete the attached consent form by writing your names, signature and date in the spaces provided. Please indicate your e-mail address if you wish to receive the questionnaire form through the e-mail.

I, ____ (name and surname),

- *Hereby give free and informed consent to participate in the abovementioned research study;*
- *Understand what the study is about and why I have been approached to participate;*
- *Understand what the potential benefits and risks that may originate from the study are; and*
- *Give the researcher permission to use the information collected from my participation for research purposes only.*

Email address: ____

Participant's signature: ___________________________ *Date:* _________________

Researcher's signature: _________________________ *Date:* ___________________

Appendix 6: Theresearch instrument

The purpose of this questionnaire is to determine what the people who are using or thinking about using information and communications technologies (ICTs) are concerned about and know at different times during the implementation process. The questionnaire is divided into three sections being: **A. Teachers' concerns, B. Teachers' knowledge, and C. Teachers' use of ICTs.** Thank you for taking time to complete this task.

A. **Teachers' concerns**: The items were developed from typical responses of school and college teachers who ranged from no knowledge at all about various programs to many years of experience in using them. Therefore, a good part of the items on this questionnaire may appear to be of little relevance or irrelevant to you at this time. For the completely irrelevant items, please **circle** "0" on the scale. Other items will represent those concerns you do have, in varying degrees of intensity, and should be marked higher on the scale, from 1 to 7.

Please respond to the items in terms of your present concerns, or how you feel about your involvement/potential involvement with ICT integration. We do not hold to any one of the definitions of ICT integration, so please think of it in terms of your own perception of what it involves. Remember to respond to each item in terms of your present concerns about your involvement/potential involvement with ICT integration.

Please circle the number of your response according to the following description;

0- irrelevant, 1- not true at all, 2- not true, 3- a little bit true, 4- more true, 5- even more true, 6 -very true, 7- extremely true, 11-no response

Items	Scale
1. I am concerned about students' attitudes towards ICT integration	0 1 2 3 4 5 6 7
2. I know of some other approaches that might work better.	0 1 2 3 4 5 6 7

3. I don't even know what ICT integration is.	0 1 2 3 4 5 6 7
4. I am concerned about not having time to organise myself each day.	0 1 2 3 4 5 6 7
5. I would like to help other departments in their use of ICTs.	0 1 2 3 4 5 6 7
6. I have very limited knowledge about ICT integration.	0 1 2 3 4 5 6 7
7. I would like to know the effect of reorganisation on my professional status.	0 1 2 3 4 5 6 7
8. I am concerned about conflict between my interest and my responsibilities.	0 1 2 3 4 5 6 7
9. I am concerned about revising my use of ICTs.	0 1 2 3 4 5 6 7
10. I would like to develop working relationships with both our department and outside departments using ICTs.	0 1 2 3 4 5 6 7
11. I am concerned about how ICT integration affects students.	0 1 2 3 4 5 6 7
12. I am not concerned about ICT integration.	0 1 2 3 4 5 6 7
13. I would like to know who will make the decisions about ICT integration.	0 1 2 3 4 5 6 7
14. I would like to know how my teaching or administration is supposed to change.	0 1 2 3 4 5 6 7
15. I would like to know what resources are available if we decide to adopt ICT integration.	0 1 2 3 4 5 6 7
16. I am concerned about my inability to manage ICT integration requirements.	0 1 2 3 4 5 6 7
17. I am concerned about evaluating my impact on students.	0 1 2 3 4 5 6 7
18. I would like to know what the use of ICTs will require in the immediate future.	0 1 2 3 4 5 6 7
19. I would like to coordinate my efforts with others to maximize the effects of ICT integration.	0 1 2 3 4 5 6 7
20. I would like to have more information on time and energy commitments required by ICT integration.	0 1 2 3 4 5 6 7
21. I would like to know how ICT integration is better that the way we are teaching now.	0 1 2 3 4 5 6 7

B. **Teachers' knowledge**: The purpose of this part of the questionnaire is to identify the type of knowledge that teachers have at a given time. **Please note that the scale will now change to a five-point scale.** Please circle the number of your response according to the following description;

1 – No knowledge at all, 2 – little knowledge, 3 – moderate knowledge, 4 – quite some knowledge, 5 – complete knowledge

Items (I have knowledge in…)	Scale
22. Solving a problem with a computer.	1 2 3 4 5
23. Using a word processor.	1 2 3 4 5
24. Using electronic spreadsheet.	1 2 3 4 5
25. Communicating through Internet tools (e.g. email, Whatsapp messenger)	1 2 3 4 5
26. Using a picture editing program (e.g. paint).	1 2 3 4 5
27. Using a presentation program (e.g. Microsoft PowerPoint).	1 2 3 4 5
28. Saving data into a digital medium (e.g. flash drive, DVD).	1 2 3 4 5
29. Assessing student performance.	1 2 3 4 5
30. Applying different learning theories and approaches (e.g. constructivism, multiple intelligence theory, project-based teaching).	1 2 3 4 5
31. Managing the classroom.	1 2 3 4 5
32. Developing class activities and projects.	1 2 3 4 5
33. Following recent developments and applications in my content area.	1 2 3 4 5
34. Following up-to-date resources (e.g. books, journals) in my content area.	1 2 3 4 5

35. Choosing technologies appropriate for my teaching or learning approaches or strategies.	1 2 3 4 5
36. Using computer applications supporting learning.	1 2 3 4 5
37. Selecting appropriate and effective teaching strategies for my content area.	1 2 3 4 5
38. Meeting objectives described in my lesson plan.	1 2 3 4 5
39. Making connections between my content area and other related courses.	1 2 3 4 5
40. Using area-specific computer applications.	1 2 3 4 5
41. Using technologies helping to reach course objectives easily in my lesson plan.	1 2 3 4 5
42. Integrating appropriate instructional methods and technologies into my content area.	1 2 3 4 5
43. Teaching a subject with different instructional strategies and computer applications.	1 2 3 4 5
44. Selecting contemporary strategies and technologies helping to teach my content effectively.	1 2 3 4 5

C. **Teachers' use of ICTs**: Please answer the following questions by **circling** the number of your response(s).

45. Do you use ICTs for teaching? **1. YES 2. NO**

46. If yes, which of the following do you use? (Please feel free to choose one or more of the listed applications).

1. Flash drive
2. DVD
3. CD
4. Printer
5. Projector
6. Scanner
7. Internet
8. Digital camera
9. Mobile phone
10. Computer

Others (please specify if there are any other technologies that you use)

____

____

47**.** How often do you use any of the ICT tools identified above for **teaching** (on average)?

1. None at all 2. Rarely, about once a term 3. Sometimes, about once a week 4. Frequently, every other day 5. Always – daily

48. Do you use ICTs for other **non-teaching** activities (e.g. administration, planning, reporting)? **1. YES** **2. NO**

49. If yes, which of the following ICTs do you use for non-teaching activities? (Please feel free to choose one or more of the listed applications).

1. Flash drive 2. DVD 3. CD 4. Printer 5. Projector 6. Scanner 7. Internet 8. Digital camera 9. Mobile phone 10. Computer

Others (please specify any other technologies that you may be using for **non-teaching** activities):

50. How often do you use any of the ICT tools identified above for **non-teaching** activities (on average)?

1. None at all
2. Rarely, about once a term
3. Sometimes, about once a week
4. Frequently, every other day
5. Always, daily

Demographic information:

Please complete the following by circling the number of your response

Gender: 1. Male 2. Female

Age: 1. 20-29, 2. 30-39, 3. 40-49, 4. 50+

Years of teaching experience:

1. 0-4, 2. 5-14, 3. 15-24, 4. 25+

Type of school:

1. Government, 2. Church, 3. Community, 4. Private

Location of school:

1. Lowlands urban, 2. Lowlands rural, 3. Highlands urban, 4. Highlands rural

Please write down any comments or questions about your experiences with the items of this instrument and also indicate any additional concerns that you may have about ICT integration or the questionnaire itself in the blank space.