DEVELOPING AND VALIDATING A NEW RELIABLE INSTRUMENT FOR ASSESSING OPEN DISTANCE LEARNING EDUCATORS' LEARNING MANAGEMENT SYSTEM - TPACK

by

Michelle Luckay, 677475

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Supervisor: Mr T Waspe

ABSTRACT

Modern-day open and distance learning (ODL) educators are increasingly being called upon to apply different forms of knowledge to integrate web-based learning management systems (LMSs) effectively for teaching and learning. To test this assumption, this study set out to develop and validate a new reliable instrument for assessing ODL educators' perceived learning management system technological pedagogical content knowledge (LMS-TPACK). Past empirical studies grounded in Mishra and Koehler's TPACK framework (2006) were examined to construct the self-report survey. Quantitative data were collected from 332 educators. Descriptive analysis, exploratory factor analysis and internal consistency reliability using Cronbach's alpha coefficients were computed. The findings reveal key LMS-TPACK constructs that have proven to be both valid and reliable. Six out of the seven subscales used to assess LMS-TPACK were found to be significant, i.e. LMS knowledge (LMS-K), pedagogical knowledge (PK), content knowledge (CK), pedagogical content knowledge (PCK), LMS pedagogical knowledge (LMS-PK) and LMS-TPACK, while LMS-CK failed to emerge in the factor structure. Several possible reasons are proposed for the lack or absence of LMS-CK. The resulting Cronbach's alpha coefficients for the different constructs as well as the overall instrument scale provide compelling evidence for stable internal consistency reliability. Alpha for the entire LMS-TPACK survey was found to be excellent (α = .931). Recommendations are made for improvements to the instrument and directions for future research are highlighted.

Keywords:

Learning management system, technological pedagogical and content knowledge, integration, open distance learning, educators, perceptions, self-report, instrument, validity, reliability

DECLARATION OF ORIGINALITY

I declare that this research report is my own unaided work. It is being submitted for the degree of Master of Education (Educational Technology) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Name of Candidate: Mrs M Luckay

Student No.: 677475

Protocol No.: 2014ECE005M

Signature: ______________________

Date: March 2017

DEDICATION

As a working wife, mother and student, these last few years have been the hardest and longest journey of my life. What a constant compromise, an endless trade-off between what is most important to me. I guess the only ones who can fully comprehend this struggle are the countless other women who have trodden the same path. One thing is for sure: without the support of loved ones, this journey would not have been possible.

For this reason, this report is dedicated to my husband, **Willy Luckay,** who not once doubted my ability to do this. No matter how many times I gave up, you hung in there with me to pursue my dream. Thank you my darling.

To my two beautiful children, **Nekita** and **Nicholas**, thank you for bearing my tacky irritableness and for understanding when I needed to go to the office to study. If anything, my hope is that you will always remember my strong conviction in education as being the most promising antidote to ignorance and life’s little imperfections.

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Love you always…

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Verily verily I say unto you, that whosoever shall say unto this mountain, be thou removed and cast into the sea, and does not doubt in his heart but believes, it will be granted to him. Mark 11:23.

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LIST OF ABBREVIATIONS AND ACRONYMS

CK, Content Knowledge

DHET, Department of Higher Education and Training

ICTs, Information and communication technologies

LMS, Learning Management System

LMS-CK, Learning management system content knowledge

LMS-K, Learning management system knowledge

LMS-PK, Learning management system pedagogical knowledge

LMS-TPACK, Learning management system technological pedagogical content knowledge

MOOC, Massive Open Online Course

ODeL, Open distance e-learning/open and distance e-learning

ODL, Open distance learning/open and distance learning

OER, Open Educational Resources

PCK, Pedagogical Content Knowledge

PK, Pedagogical Knowledge

SAQA, South African Qualifications Authority

TCK, Technological Content Knowledge

TK, Technological Knowledge

TPACK, Technological Pedagogical Content Knowledge

TPCK-W, Technological Pedagogical Content Knowledge-Web

TPK, Technological Pedagogical Knowledge

UNISA, University of South Africa

WCK, Web-content knowledge

WPCK, Web-pedagogical content knowledge

WPK, Web-pedagogical knowledge

CHAPTER ONE

FRAMING THE STUDY

1.1 INTRODUCTION

Modern-day open and distance learning (ODL) is a transforming feature in higher education, and change has been strongly linked to, if not propelled by, advances in information and communication technologies (ICTs) (Bates, 1997; 2008). Previous modes of distance education, i.e. correspondence courses, radio-based courses and videotaped lectures, are either being revised or replaced by more internet- or web-based learning management system (LMS) modes of delivery (Garrison & Cleveland-Innes, 2010). The push toward open and distance e-learning (ODeL) or online learning[1] is happening for a variety of socioeconomic and political reasons, including the need to provide alternative access to quality university education, increase communication and engagement, support remote students and prepare graduates for meaningful participation in a digital world (South Africa. Department of Higher Education and Training (DHET), 2014a and b).

Despite the changing context of ODL, research has shown that the integration of LMS environments in teaching and learning poses challenges to educators (Weaver, 2006; Mostert & Quinn, 2009). The dilemma for distance educators is that while these web-based environments provide a variety of communication, content and assessment tools, many have difficulty integrating LMS as staff are utilising its capabilities to replicate their traditional practices and content. Sife, Lwoga and Sanga (2007) suggest that their apparent failure to integrate LMS is because "their plans appear to be driven by ICTs and not by pedagogical rationale" (para. 25). Nonetheless, Anderson and Garrison (1998), Bates (1997) and Unwin (2007) suggest that successful pedagogical integration of ICTs necessitates a transformation process, where educators have to rethink and re-

[1] The terms 'e-learning' or 'online learning' describe internet- or web-based teaching and learning that delivers content and supports communication and collaboration between instructor and students (Garrison & Cleveland-Innes, 2010).

examine their existing professional roles and competencies and begin to operate differently. If educators are to incorporate ICTs successfully for teaching and learning, many more than minor changes in current practices will be needed.

To respond to the issue of what more is needed for effective integration of ICTs in teaching and learning, Henry and Meadows (2008) propose that "because the online world is a categorically different environment, a particular blend of skills and knowledge is necessary if success is to be found in this domain" (para. 53). Similarly, Mishra and Koehler (2006) believe that thoughtful pedagogical integration of new technologies in teaching can only be realised if educators possess unique knowledge known as technological pedagogical and content knowledge (TPCK). The TPCK framework, also commonly known as TPACK[2], describes the various kinds of knowledge required by educators for meaningful technology integration in teaching. In so doing, they highlight the complex interplay between technology knowledge, pedagogical knowledge and content knowledge, "while addressing the complex, multifaceted and contextual nature of this knowledge" (Mishra & Koehler, 2006, p. 1017).

Since its inception, TPACK has been widely adopted, fuelling numerous research efforts describing the development and assessment of TPACK (Archambault & Crippen, 2009; Koh, Chai, & Tsai, 2014; Landry, 2010; Lee & Tsai, 2010; Lux, Bangert, & Whittier, 2011; Sahin, 2011). Much of this work has intended to provide empirical evidence for the TPACK framework and its distinct constructs and to validate the reliability of assessment methods and instruments used to measure TPACK (Burgoyne, Graham, & Sudweeks, 2010; Chai, Koh, & Tsai, 2011; Dinh, 2013; Schmidt et al., 2009; Shinas, Yilmaz-Ozden, Mouza, Karchmer-Klein, & Glutting, 2013; Yurdakul et al., 2012). This study aimed to support the development of a new learning management system technological pedagogical content knowledge (LMS-TPACK) instrument for measuring ODL educators' perceived knowledge and ability to teach effectively using the LMS. More specifically, the research sought to test the validity and

[2] The acronym TPCK was later changed to TPACK for ease of pronunciation and to reflect the idea that the three knowledge domains, i.e. technology, content and pedagogy, "should not be taken in isolation, but rather that they form an integrated whole, a 'Total PACKage' as it were" (Thompson & Mishra, 2007, p. 38).

internal consistency reliability of the instrument within a developing country, in a transitioning ODL context.

1.2 A TRANSITIONING ODL CONTEXT - THE CASE OF UNISA

Historically the University of South Africa (UNISA) established itself as a correspondence distance education institution providing print-based materials as its main form of teaching. By the 1970s radio, audio and video cassette technologies were made available in an attempt to bridge the distance gap between the institution and its students. More recently, the university is a transitioning ODL institution that encourages resource-based learning (UNISA, 2008, p. 2). UNISA's wide range of learning resources, i.e. print-based materials, radio, audio and videoconferencing, CDs, DVDs, satellite broadcasting, etc., was bolstered in 2006 with the institution's adoption of the Sakai open-source software platform as its centrally supported LMS. Branded as myUNISA, the access-controlled LMS allows for the online transmission of course content and contains test generators and assessment tools (Malikowski, Thompson, & Theis, 2007). It also boasts synchronous and asynchronous communication features that can be used to facilitate various forms of interaction (Anderson & Garrison, 1998; Coates, James, & Baldwin, 2005).

The shift from ODL to ODeL denotes UNISA's changeover toward more online or e-learning programmes. The university is growing new online courses, resulting in an increasing need for effective integration of ICTs to support e-learning. Integration of ICTs, more specifically the integration of the myUNISA LMS, has been identified as a significant platform to help UNISA achieve its 2016-2030 Strategic Plans. While the integration of LMS-based teaching has not been mandated, individual staff members have to supplement or blend print-based modules (or in some cases even replace them altogether with fully online courses) together with the use of massive open online courses (MOOCs) and open educational resources (OERs). Moreover, they are encouraged to integrate tools such as online discussions, wikis, blogs, media, social networking applications and e-portfolios in the design and development of quality online distance courses along with innovative digitised teaching methods to meet the needs of 21st century students.

1.3 STATEMENT OF THE PROBLEM

Being mindful of the fact that the introduction of the institutional LMS would impact on the traditional roles and competencies of future ODeL professionals (Arinto, 2013; Thach & Murphy, 1995), it was necessary to provide skills training workshops to help educators cope with changes in the design and delivery of hybrid and/or fully online distance courses. As a consequence, development support staff presented a series of professional development workshops focused on isolated technology skills training, teaching educators *how* to use the myUNISA LMS tools. However, the underlying conception is that "by demonstrating their proficiency with current software and hardware, [educators] will be able to successfully incorporate technology" into their teaching practice (Mishra & Koehler, 2006, p. 1031).

While these presentations led to knowledge *about* myUNISA tools, they did not lead to significant learning on *how to* integrate the LMS in a pedagogically sound manner. Rudimentary LMS tools training did not automatically lead to technology integration or good teaching with the LMS as "knowing how to use technology is not the same as knowing how to teach with it" (Mishra & Koehler, 2006, p. 1033). Standalone myUNISA technology knowledge did not adequately address the content-specific issues or online delivery methodologies which are compatible with ODL learning theories that intertwine with LMS application. Instead, distance educators continue to be "confronted with the challenges and questions of how and when to incorporate such technologies for teaching and learning" (Niess, 2011, p. 299).

Despite the many difficulties that have been raised regarding the integration of LMS as an instructional tool, its application has continued to dominate as the preferred technology on the higher education front. This trend has highlighted the importance of assessing educators' knowledge, i.e. what educators know and understand, and are able to do with regard to teaching in the new online environment. While use and interest in the institutional LMS of myUNISA has increased over the last few years, there is a real need to critically examine integration practices and to take into account the different kinds of knowledge necessary by soon-to-be ODeL educators to ensure meaningful teaching with the LMS. Up until now no institutional audit has been conducted to assess the impacts of training, nor has there been any form of evaluation of current myUNISA knowledge and competences of distance educators. In an effort to guide and improve the understanding of what constitutes successful and/or meaningful teaching with the LMS, it has become necessary to measure the knowledge and abilities for effective LMS integration in the form of a self-assessment tool.

1.4 PURPOSE OF THE STUDY

The study was informed by the researcher's own experience since joining UNISA in 2008. As a qualified teacher and geography content expert, even after having attended several myUNISA training and staff development workshops, she found it difficult to incorporate the institutional LMS, myUNISA, to design authentic learning experiences while teaching Geography. Integrating the LMS to support distance learning was challenging as it required the researcher to infuse knowledge of the LMS, pedagogy and content (Geography). In addition, the lack of an analytical tool at UNISA prompted the researcher to develop and test the validity and reliability of a new LMS-TPACK measurement instrument. The measuring tool assesses distance educators' self-perceptions of their LMS-TPACK.

The three adjoining objectives of this research were to: (1) examine Mishra and Koehler's TPACK constructs (2006) to better understand the various domains of knowledge they address, and (2) identify features that characterise effective teaching with the LMS, especially the knowledge and capabilities that underpin effective LMS teaching within a transforming ODL context. In addition, to assist with the development and validation of a new reliable LMS-TPACK instrument, this study (3) reviewed and adapted numerous self-reporting instruments developed for measuring teaching staff's TPACK (Archambault & Crippen, 2009; Dinh, 2013; Lee & Tsai, 2010; Lux et al., 2011; Koh et al., 2014; Schmidt et al., 2009; Yurdakul et al., 2012).

1.5 RESEARCH QUESTIONS

The present study focused mainly on LMSs. Thus, the term LMS-TPACK will be used to denote TPACK as it relates exclusively to LMS technology. In particular, this study examined the theoretical constructs of TPACK as they relate to ODL educators and developed a validated LMS-TPACK survey instrument to measure UNISA educators' self-perceptions of TPACK, i.e. their knowledge and skill to integrate LMS for teaching.

To address the objective of this study, the following research questions were used:

1.5.1 Main question

Is the developed instrument valid and reliable for the purposes of assessing ODL educators' perceived LMS-TPACK?

1.5.2 Sub-questions

(a) What are the *constructs and underlying dimensions* that need to be measured to ascertain LMS-TPACK?

(b) Will the measuring instrument developed be *valid and reliable* for measuring the seven TPACK constructs described by Mishra and Koehler?

1.6 RESEARCH ASSUMPTIONS

The assumptions that underlie this study are that the TPACK framework and its adjoining constructs exist and are quantifiable and that data gathered from the self-report survey are taken to be accurate.

1.7 SIGNIFICANCE OF THE STUDY

While numerous studies have sought to develop and establish valid instruments for assessing perceived TPACK, there is as yet no widely accepted standardised instrument (Albion, Jamieson-Proctor, & Finger, 2010). According to Dinh (2013), "existing survey instruments have mainly been developed for use with pre-service educators in developed countries [and] therefore do not meet the context needs if they are to be applied for educators in developing countries" (p. 2566). What is more, the absence of precise definitions makes it difficult to construct robust instruments for measuring TPACK in a variety of contexts. It has been argued that nebulous boundaries are associated with the TPACK model (Angeli & Valanides, 2009; Archambault & Crippen, 2009; Graham, 2011), that the description of TPACK and its related constructs "are not clear enough for researchers to agree on what is and is not an example of each construct" (Cox & Graham, 2009, p.60). Consequently, Archambault and Barnett (2010) recommend that "more research regarding the validity and applicability of TPACK framework is needed" (p. 1658).

Hence, this study undertook to help improve the current understanding and operationalisation of widely accepted TPACK, particularly its application within a transformative multicultural, multilingual South African ODL context. It is also hoped that since no standardised institutional integration matrix exists, the validated LMS-TPACK instrument can serve as a beginning promising toolkit. A new LMS-TPACK tool can stimulate reflection and facilitate renewed understandings of the structures of knowledge and skills required to enhance effective pedagogical LMS integration practices. In addition, the LMS-TPACK instrument can offer guidelines of what educators should know and be able to do when integrating LMS functionality in distance e-learning. The effects of ill-prepared educators can hamper teaching and learning and so the results of this study can prove useful to inform policy makers and institutional stakeholders and allow managers and professional development support staff to take appropriate steps in planning for improved LMS integration that promotes student learning.

1.8 SUMMARY

To summarise then, the following conclusions can be drawn: Newer digital technologies are having a profound impact on ODL. ODL institutions are slowly moving away from print and broadcast technologies and to a greater extent adopting and integrating more internet- or web-based LMS tools for teaching and learning. The trend is toward more e-learning. This changing context presents new challenges, impacting on distance educators' old established ways of doing things. Increasingly, 21st century distance educators are being called upon to integrate LMS technology in teaching. While universities continue to strengthen the move toward e-learning, teaching with LMS technology remains challenging. Numerous studies have revealed that educators require a special blend of knowledge and skill for meaningful integration of technology in teaching (Henry & Meadows, 2008; Mishra & Koehler, 2006). Hence the purpose of this study was to develop and test the validity and reliability of an LMS-TPACK instrument by identifying the kinds of knowledge and abilities that underlie effective distance teaching with the LMS.

1.9 STRUCTURE OF THIS REPORT

The structure of this report is as follows:

This chapter (**Chapter 1**) begins with an introductory orientation to the study. The problem statement, purpose, research questions and assumptions as well as significance of the study are also contained in this chapter.

In **Chapter 2** core terms that underlie contemporary open, distance and e-learning are identified and defined and the relevant literature is reviewed. The TPACK framework and conceptual framework as well as numerous research efforts attempting to measure TPACK are outlined.

Chapter 3 sheds light on the importance of measurement development, particularly the guiding principles and techniques as they relate to the issue of validity and reliability.

Chapter 4 gives details of the research design and methodology used for developing the LMS-TPACK survey, including the instrumentation, data collection and data analysis techniques.

Chapter 5 is a summary of the results and findings from the data collected, while **Chapter 6** presents a discussion and conclusion, and recommendations for future research are highlighted.

CHAPTER TWO

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 INTRODUCTION

This chapter builds on from the previous one, which provided an introductory orientation to the study. Various facets pertaining to the research problem and way in which the study was conducted were described. What follows here is less of a conventional literature review and more of an elaboration of the conceptual framework. Guided by the research questions, the first part of the chapter starts with a definition of core terms that underline modern-day open, distance and e-learning, including the notion of affordances. Central to this literature are UNISA policy and conceptions that shape existing institutional teaching practice within the context of this study.

While it is not the researcher's intention to give a technical analysis of an LMS, it would be helpful to give some information for those less familiar with the system. Subsequently, directed by the problem statement and purpose of this report, the literature review covers key facets focusing on the following: (a) LMS affordances for teaching and learning, (b) how the pedagogical affordances of a current institutional LMS (myUNISA) are being used to support ODL, (c) constraints associated with the pedagogical integration of LMSs, (d) Mishra and Koehler's TPACK framework (2006), (e) the conceptual model as well as (f) earlier research efforts attempting to measure TPACK.

2.2 DEFINITION OF CORE TERMS

According to Lewis (1986), as always, definitions of wide-ranging terms often offer considerable confusion about what they are and what they are not. Influenced by disparate settings, the manner in which a family of phrases associated with open, distance and e-learning are interpreted and practised is often misleading (Guri-Rosenblit, 2005; Rumble, 1989). For the sake of clarity and a common understanding, the researcher reviewed the relevant literature as well as institutional policies to determine how the terms of interest are defined and exercised within the context of this study.

2.2.1 What are ICTs?

Lloyd (2005) cites a useful definition by Toomey (2001), who defines information and communication technologies (ICTs) as "those technologies that are used for accessing, gathering, manipulating and presenting or communicating information" (p. 3). These technologies include hardware, software and internet connectivity, as well as a wide assortment of multimedia tools and resources. For example, ICTs include computers, mobile devices, digital cameras, radio and television, videoconferencing technology, mind mapping software, notetaking software, Assessment Master (online testing software), and so on. While the above definition denotes a broad domain, ICTs are often spoken of in a particular context, such as economics, health or education.

2.2.2 What varieties of ICTs are commonly used in distance education?

ICTs in distance education typically involve a combination of different technologies used as instructional tools. For instance, older technologies such as print-based materials (e.g. study guides, tutorial letters), combined with textbooks and readings are supported by radio and/or television broadcasts and videoconferencing technologies. However, in recent years, there has been an upsurge of interest in how ICTs, particularly internet- or web-based applications, can best be harnessed to help broaden access and improve the efficiency and quality of higher distance education.

Nowadays virtual technologies - whether solely or partially – are increasingly being used to deliver courseware, increase interactions and/or facilitate learning. Arinto (2013), in her analysis of distance education, reports that internet-based technologies involving LMSs are transforming distance education and replacing traditional print-based modes of delivery with more flexible online modes of delivery. Likewise, Yueh and Hsu (2008) also found that instructional activities such as "presenting information, managing course materials, and collecting and evaluating student work can now be completed online using LMS" (p. 59).

2.2.3 What is a Learning Management System (LMS)?

An LMS is defined by Unwin et al. (2010) as being a web-based application that is used to structure, disseminate or access particular learning courses. Similarly, Watson and Watson (2007) describe LMS as:

> *the framework that handles all aspects of the learning process. LMS delivers and manages instructional content, identifies and assesses individual and organizational learning or training goals, tracks the progress towards meeting those goals, and collects and presents data for supervising the learning process of an organization as a whole.* (p. 28)

Other terms used to refer to LMSs include course management systems, instructional management structures, learning platforms and distributed learning systems (Coates et al., 2005). These applications typically include a range of administrative and pedagogical tools used for designing, constructing and delivering online learning environments and can also be used to operate entire virtual universities. What is more, LMS-enabled course sites permit educators and students to share study material, create class notifications, submit and return coursework as well as connect and interact with each other in an online virtual learning environment (Lonn & Teasley, 2009).

While a variety of definitions exist, given the context of this study, this report uses the term 'learning management system (LMS)' to refer to a software application used for creating, organising and delivering academic and administrative as well as student support functions online. LMS capabilities include the uploading of digital courseware (e.g. videos, PowerPoint presentations, PDFs, live content), e-assessments and automated marking. It also includes a number of communication tools used to facilitate active engagement and collaboration and allows instructors to track, monitor and record student learning by accessing detailed statistical reports in a virtual learning environment.

2.2.4: Learning environments: ODL and ODeL, what are they?

UNISA definitions

Open distance learning (ODL) is defined as:

> *a multi-dimensional concept aimed at bridging the time, geographical, economic, social, and educational and communication distance between student and institution, student and academics, student and courseware and student and peers. ODL focuses on removing barriers to access learning, flexibility of learning provision, student-centeredness, supporting students and constructing learning programmes with the expectation that students can succeed.* (UNISA, 2008, p. 2)

More recently, the emergence of newer web-based technologies has brought about changes in the design and delivery of courses and has led UNISA management to coin the term 'open distance e-learning (ODeL)'. The 'e' in ODeL implies increased use of ICTs, entailing the integration of existing technologies including the institutional LMS called myUNISA. myUNISA affords new possibilities to enhance organisational and operating systems and represents a change in the primary mode of teaching and learning.

In this study, ODeL is not used synonymously with fully online distance e-learning. ODeL does not imply that UNISA will no longer have face-to-face interaction with students, nor does it mean that the use of text will be completely phased out. Instead, it is recognised that learning can also take place offline when students are not connected to the LMS. As an enhancement of ODL, UNISA's description of ODeL highlights the convergence of distance education (a method of education provision) and the philosophy of open learning with the adoption of e-learning technologies and pedagogies to support a blended learning approach.

It is important to note that while the concepts formulated here (below) have salience for the instrument development; the instrument will not be measuring knowledge of these different concepts, e.g. blended learning and flexible learning.

2.2.5 What is blended learning?

The term 'blended learning' is used widely in the teaching and learning literature. UNISA's ODL Policy (2008) maintains that blended learning is accomplished by employing numerous teaching and learning strategies, mixing an assortment of technologies with face-to-face interaction and applying tangible physical and virtual resources. For example, students engaged in distance learning can be offered both print-based and online learning resources, have e-tutorials and participate in online class discussions that can be enhanced by intermittent face-to-face tutorials at regional learning centres. Tinio (2003) claims that blended learning "was prompted by the recognition that not all learning is best achieved in an electronically-mediated environment" (p. 4). She feels that special attention ought to be given to the diverse needs, capabilities and learning styles of distance students in order to arrive at an optimum mix of instructional and delivery modes to achieve flexible learning.

2.2.6 What is flexible learning?

Many universities are linking the application of ICTs in teaching and learning to the concept of student-centredness and labelling the emergent educational practices as flexible learning. Steeples, Goodyear and Mellar (1994) recognise that a growing diversification and a more heterogeneous student body are reshaping higher education and triggering more responsive forms of education. These changing ICT-augmented teaching and learning patterns are increasingly encouraging students to assume more responsibility and independence and manage their own learning. On the other hand, Taylor (2000) suggests that rather than just using ICTs to disseminate content, the resultant flexible learning environment can be used to accommodate the diverse needs, capabilities and learning styles of students as well as "provide a breadth of opportunities to study, and enhance access for those who are unable to attend the campus regularly" (p. 110). This kind of flexibility allows students to break free from the constraints of timetabled classes at central venues, giving them greater choice over what, when and how they learn. Similarly, Nicoll (1997) believes that this method of teaching denotes "a 'better' form for the delivery of learning" (p. 100) that encourages student-centred learning by allowing students to learn and access materials in their own time and space.

2.2.7 What is student-centred learning?

Another term that has gained prominence in education is ‘student-centred learning’. UNISA’s definition of student-centredness “requires that students are seen as the main foci of the educational process and they are supported to take progressive responsibility for their learning” (UNISA, 2008, p. 2). The main ideas that underpin student-centred learning appear to be founded on constructivist learning theories, which view learning as an active process in which students construct meaning based on prior knowledge and authentic experiences. That is to say, knowledge is not out there, detached from the student, which the student passively needs to be filled with or given. Instead, constructivists claim that new insights and new experiences are created through active participation, in which students’ prior knowledge and experiences become modified and transformed while learning. Hence, student-centred instructional methods employed should afford students opportunities to actively engage with the environment, content and with others; establish links between students’ prior knowledge, everyday real-life experiences and new knowledge to be constructed, as well as encourage independent and critical thinking (UNISA, 2008).

2.2.8 What is meant by student support?

Student support is a broad term that relates to a variety of services (i.e. academic and non-academic) designed by distance education institutions to help students to achieve their learning outcomes and to gain the knowledge and skills needed to complete their qualification(s) successfully (Simpson, 2013). The varieties of student support include:

- in-text support in the form of well-designed well-integrated **courseware;**

- support in the form of **tutorials** where the learning materials are mediated either through a certain amount of on-site face-to-face contact with tutors and/or online or e-tutorial support accessible to all students, irrespective of geographic location;
- support in the form of generic and/or personalised **feedback** that could take the form of test scores, written or spoken comments to formative assessments, so that if necessary, corrective action can be taken;

- support in the form of **practical work** or experiential learning, linking learning to the place of work; in this way, students are provided with on-the-job training and an opportunity to observe, manipulate and master the application of theory in a real-life setting such as a laboratory, etc.

- harnessing **appropriate ICTs** to help broaden support to students, i.e. print, satellite broadcasting, radio and television, SMS, email, radio, social networking tools, etc., including myUNISA LMS (UNISA, 2008).

Core terms associated with open, distance and e-learning as used within the context of this study have been defined in this section. These concepts as formulated above are more of a conceptual framework than a literature review per se, and the analysis and interpretations of these concepts are relevant for the development of a scientific instrument. The next paragraphs deal with the notion of affordances, which centres on how ICTs in distance education, especially the virtual teaching environment, is perceived by educators, i.e. what knowledge the user has of LMS, including all actions that are possible.

2.3 AFFORDANCES

Online learning environments, particularly those associated with the use of LMSs, are increasingly being described in terms of affordances. Boyle and Cook (2004) and John and Sutherland (2005) suggest that the term is generally used to draw attention to the pedagogical opportunities of ICTs. Norman (1988) defines affordances as:

> *the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used… Affordances provide strong clues to the operations of things. Plates are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing. When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction needed.* (p. 9)

Most notably, Norman (1990) elucidates that affordances are not solely derived from the invariant or unchanging properties of the object or tool, but are also shaped by perceived properties, that is, a knowledge or understanding of how the inherent properties can possibly be used. Once the perceived and actual properties become unified, an affordance arises as a connection that holds between the entity and the person that is acting on the entity. Contrary to Norman's theory of affordances is John and Sutherland's conceptualisation (2005); they deny that there is anything innate in technology that instinctively ensures learning. Instead, they believe that effective teaching and learning with technology can only come about when meaningful integration of technology, pedagogy and content takes place within particular learning environments.

Drawing from what has been articulated above; the concept of affordances proves useful for the development of the LMS-TPACK instrument. In accordance with Norman's conceptualisation of affordance (1998), this study concurs that LMS affordances arise as a connection that holds between the LMS and the educator that is acting on the LMS. Affordance therefore centres on two main features: (1) perceived properties of LMSs, e.g. knowing how LMSs can or should be used to enhance pedagogy, content and ultimately learning, and (2) invariant properties of LMSs, i.e. the actual inherent features, tools and capabilities of LMSs, including their constraints. See Figure 1, an illustration of the application of Norman's conceptualisation of affordances to LMS which represents a useful approach to developing LMS-TPACK.

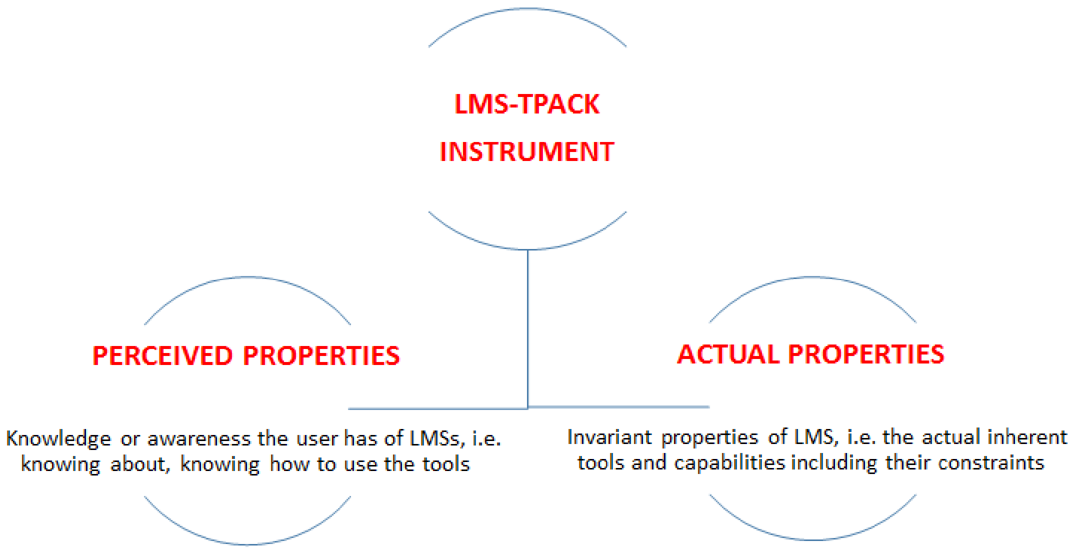

Figure 1: *Concept of affordances (adapted from Norman, 1998)*

In the next section the notion that LMSs have affordances is explored. The literature on current uses of LMSs, including Sakai suite (SAKAI, 2016), was reviewed and analysed to identify key properties or features and establish common themes under discussion. From this analysis the different LMS affordances were mapped to particular uses and placed in given domains. Mapping refers to the activity of representing connections among the affordances of LMSs, pedagogy and content. A taxonomy of Sakai LMS affordances was framed to depict the arrangements of and relationships between the actual properties of LMSs, particularly what educators can do (actions possible) with an LMS as a powerful teaching tool. The taxonomy provides a description of each category and serves as a mapping tool for the development of LMS-TPACK.

It is argued that an explicit formulation of LMS affordances can improve educators' knowledge of the different functional properties of LMSs that enable educators' "know how" of the different features that might be used to support teaching and learning more effectively. It is also believed that any one affordance can offer both opportunities and constraints.

2.4 LMS AFFORDANCES FOR TEACHING AND LEARNING: A TAXONOMY AS A MAPPING TOOL FOR DEVELOPING LMS-TPACK

The literature documents several prominent LMS features and categorises the ways in which learning platforms are being used to support pedagogical actions.

Malikowski et al. (2007) have identified five categories of LMS features for higher education application: (1) transmitting course content, (2) creating class discussions, (3) evaluating students, (4) evaluating courses and instructors, and (5) creating computer-based instruction. Similarly, Griffin and Rankine (2010) arrange the affordances of LMS tools for academics into functional quadrants: (1) communication and collaboration, (2) content and resources, (3) evaluation and assessment, and (4) site management. They acknowledge that differentiating between LMS teaching and administration tools is no simple task.

For the purpose of this study, the researcher deemed it useful to illuminate and define categories and features associated with the Sakai LMS suite (see Figure 2). These categories are: (1) content design, use and reuse, (2) interaction, (3) web-based instruction, (4) e-assessment, and (5) site management and housekeeping. A description of each category is provided below. Also see Figure 2.

2.4.1 Category 1: Content design, use and reuse

This category refers to the combined capabilities associated with creating, using, reusing, storing and delivering digital content by means of an LMS.

Schramm (1977) believes that learning is shaped more by the contents in the learning materials than by the kind of technology used to deliver instruction. Online content, according to Cole (2000), must be appropriately designed to engage the student and promote learning. Kozma (2001), on the other hand, argues that even though it is not the technology per se that influences learning; particular attributes of technology are needed to influence learning.

In an analysis of the effects of LMSs on university teaching practices, Coates et al. (2005) found that these online platforms are simplifying the development of digital study materials, making it possible to design, structure and deliver virtual content. Even though particular limitations are imposed by these systems, "staff are able to develop interactive web pages, upload and integrate digital resources" (p. 22). Malikowski et al. (2007), Singh, Mangalaraj and Taneja (2010) and Dobozy and Reynolds (2010) highlight that LMSs are commonly used by instructors to transmit course content. This, they claim, is usually made available to students in the form of electronic word processor files, PowerPoint presentations and HTML files, and typically includes study guides, course outlines, exam examples, readings and assignments as well as lecture/class notes and multimedia files such as slides and videos.

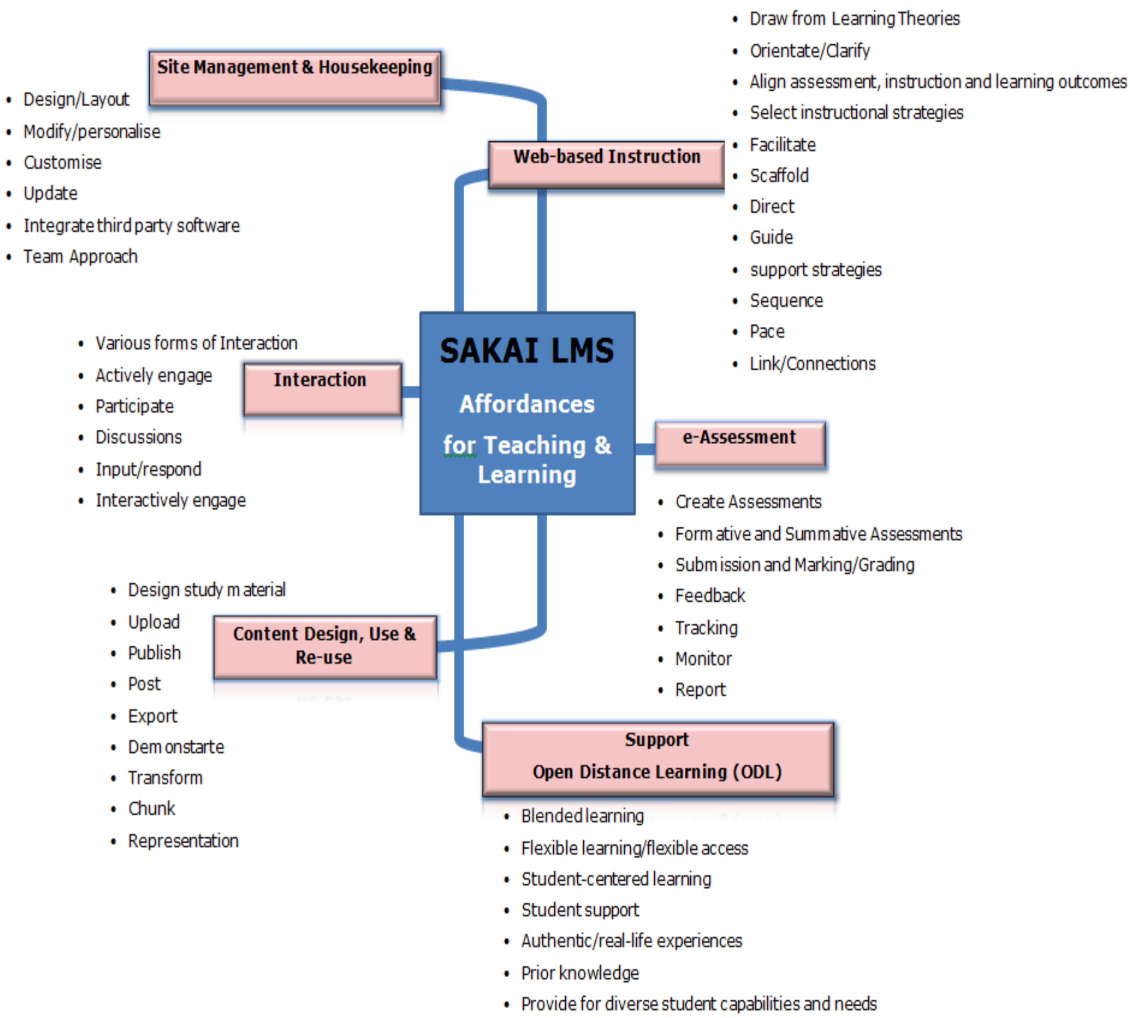

Figure 2: *Taxonomy of LMS affordances for teaching and learning (adapted from Sakai Learning Management Features, SAKAI, 2016)*

In another study, Mlitwa (2007) observed how these online learning environments "support flexible storage and display options, and provide a simple yet powerful publishing format" (p. 7). Singh et al. (2010, p. 302) report that LMS platforms allow instructors to post information about course supplementary materials, deadlines and events to a course website by means of announcements or they can even send automated email messages directly to the class. Malikowski et al. (2007) demonstrate how LMSs allow electronic data such as portfolio usage, statistics, marks, etc. to be exported out of a central database and later used to generate predefined reports in various formats. For example, data can be imported into word processor or Excel spreadsheets and the "statistical tools can show if students have viewed information that an instructor transmitted or how students have interacted" in the LMS (p. 150).

Griffin and Rankine (2010) highlight that LMSs allow educators to "design units in small, reusable chunks that can be independently reused or repurposed as necessary" from semester to semester (p. 516). Tinio (2003) found that the internet and related technologies and tools, when used appropriately, can facilitate the transformation of content. She claims that teaching with networked technologies means focusing on how the different tools can be used to teach across the curriculum. This includes the use of presentations, demonstrations and the application of games, simulations, multiple visualisations and graphical representations online of obscure abstract concepts, as well as combining "text, sound, and colourful, moving images to provide challenging and authentic content that will engage the student in the learning process" (p. 7).

2.4.2 Category 2: Interaction

This category refers to the assortment of interactive tools embedded in LMS environments intended for connecting users, creating discussions and structuring interactions that can contribute to learning.

Interaction has been documented as a vital component in education and is believed to be key to effective learning (Holmberg, 1995; Moore, 1989). In distance education where direct face-to-face contact is limited or non-existent, different technologies, including LMSs, are used to facilitate various forms of interaction to support and enhance meaningful learning, e.g. interaction between student-student, student-lecturer/tutor, student-content and student-interface (Anderson & Garrison, 1998; Anderson, 2003; Hillman, Willis, & Gunawardena, 1994). See Figure 3, Anderson's modes of interaction in distance education (2003).

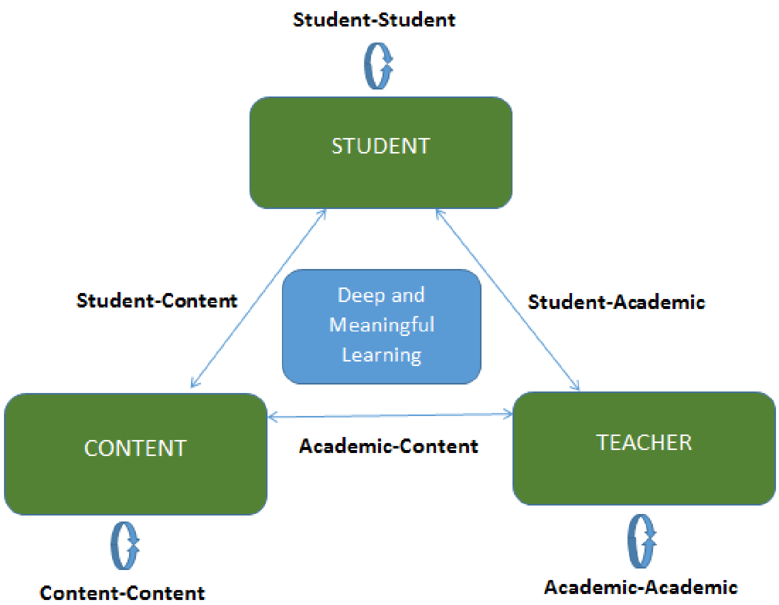

Figure 3: *Modes of interaction in distance education (adapted from Anderson, 2003, p. 133)*

Lonn and Teasley (2009) explored the uses of LMSs and found that these online applications contain tools that provide for interaction among students and educators as well as among peers. They point out that LMS functionalities are increasingly affording the varieties of online engagement preferred nowadays by students, such as discussion forums, blogs and wikis. This view is in line with Hillman et al. (1994), who considered the interaction that occurs when students manipulate and use these intervening technologies to "communicate with the content, negotiate meaning and validate knowledge with the instructor and other [students]" (pp. 30-31).

According to Vovides, Sanchez-Alonso, Mitropoulou and Nickmans (2007), these virtual environments provide features that allow students to participate in synchronous and asynchronous interactions with their peers and with the educator. Similarly, Schroeder, Minocha and Schneider (2010) claim that the interactive capabilities of

LMSs allow students to collaborate and learn interactively. More specifically, they point out that blogs afford students opportunities to disclose their experiences and to offer each other support, which is particularly important in the absence of face-to-face contact in distance education.

Northrup (2001) and Muirhead and Juwah (2004) in Woo and Reeves (2007, p. 16) identify several functions of web-based interaction in the learning process, including affording students opportunities to interact with the content and to make inputs to and respond in the learning process. Neo (2005) notes that students who use the collaborating features of constructivist online learning environments are more likely to interactively engage in seeking out knowledge and information as well as “take an active part in their own learning process” (p. 7).

2.4.3 Category 3: Web-based instruction

While the objective of any instructional approach is to advance learning, an LMS can be used to create web-based instruction as an alternative medium to enhance distance education and to offer blended courses, i.e. combine print, online, face-to-face and other media (Morgan, 2003). Examples are given in the next paragraphs of online instructional strategies by applying the unique functionalities inherent in an LMS.

Ally (2004) in Anderson (2008) encourages educators to “tacitly or explicitly know the principles of learning and how students learn” before designing study materials for distance online learning (p. 18). He claims that distance educators must be able to draw from sound proven learning theories such as behaviourism, constructivism and cognitivism when developing online learning materials. He also believes that when designing online learning materials, any one or combination of learning theories can be used as each holds its own accounts of the benefits of using technology for teaching and learning. Moreover, Ally argues that “to select the most appropriate instructional strategies” the online educator must know the different philosophies of learning, i.e. strategies to motivate students and cater for diverse needs and capabilities, facilitate various forms of interactions and provide scaffolding during the learning process (Anderson, 2008, p.18, Collins, 1996).

An instructional strategy such as scaffolding represents the integration of various support strategies used to help students accomplish complex tasks. These can be given in the form of tutorials, hints and reminders, links and frequent feedback, as well as monitoring students' learning. These offer powerful enhancements to the teaching and learning transaction. Vovides et al. (2007) point out the powerful built-in features and functionalities of current LMSs that can provide for a wide range of scaffolding to students online. For instance, LMS capabilities allow educators to plug into a vast selection of supplemental materials through Rich Site Summary/Really Simple Syndication (RSS) feeds. In this way an educator can direct and guide students to appropriate web-based course-related content to access current news, online publishers, libraries, etc. without having to visit the actual source or site (Singh et al., 2010, p. 302).

Oliver, Herrington and Omari (1996) caution that while online learning environments offer a popular and useful instructional medium, the use of "electronic learning materials can easily conceal information and content they contain" (p. 3). They maintain that it is important at the onset of the design process to orientate students to allow for free easy movement in the virtual learning space. Ally (2004) in Anderson (2008) highlights that a number of online strategies can be used that enable students to process the learning materials efficiently. These include:

- **sequencing** the learning materials appropriately to promote learning. This could take the form of simple to complex tasks, a notion akin to Vygotsky's zone of proximal development (1978). Vygotsky highlighted the importance of support, interaction and mediated learning and claimed that the help or assistance from a more experienced knowledgeable other, be it a teacher or peer(s), can provide the support needed to master complex tasks.

- **chunking** or organising the content, e.g. splitting or breaking the content up into several smaller segments to facilitate processing.

- **pacing** the learning so that students are able to move independently through a course based on individual competencies or time availability and master the content.

- **linking** or **connecting** current meanings and context and the new information to be learnt, which can enhance learning, particularly when the associations between related information are made explicit and recognised (Anderson, 2008).

2.4.4 Category 4: E-assessment

This category describes an LMS's ability to support multiple e-assessment practices used as a part of instruction to enhance the learning process.

Opportunities for assessing student understanding and mastery of content represent an essential part of the learning process. If clearly aligned from the outset, different assessment strategies (e.g. formative, summative assessments) can meet a variety of instructional and learning outcomes (Biggs, 2011; Shepard, 2000).

Malikowski et al. (2007) report that the LMS quiz generator represents the most common tool utilised to create multiple assessments online (e.g. tests and quizzes, surveys, self-assessments and timed assessments). These assessments comprise question pools usually supplied by textbook publishers and contain a variety of question types that can be directly imported into the LMS, including closed/open-ended questions, "multiple choice, matching, ordering, arithmetic, long answer, short answer, fill in the blank, and true and false" (p. 161). Sclater (2008) identifies how these centrally hosted systems allow for the electronic "submission and marking of assignments online" (p. 7). Similarly, Griffin and Rankine (2010) highlight that LMSs' automated marking capabilities enable prescribed comments to be inserted into written assignments before marked scripts are returned to students online.

In 2003, Morgan examined how a faculty in the University of Wisconsin utilised the LMS to design feedback online, reporting elements likely to lead to self-correction and improvement. They made use of the LMS as a way to enhance the amount and variety of feedback and to improve the promptness of feedback back to students. An important feature of this feedback was the use of comments in the online grade book. Jurado and Pettersson (2011), on the other hand, found that LMS course tools were "primarily used to monitor and document the educational process" (p. 4) and, when manipulated, can be used to “provide reports to management” (Aydin & Tirkes, 2010, p. 593). Additionally, Simonson (2007) reports that LMSs make it far easier to “track student performance” (p. vii) and permit instructors to view and log system usage by users, events and resources effortlessly (Sclater, 2008).

2.4.5 Category 5: Site management and housekeeping

This category refers to the logistical and configuration activities necessary for designing and managing an LMS-based teaching and learning environment. A particular toolset serves as a means to structure the platform for learning events and to match a particular or a combination of pedagogical theories.

According to Coates et al. (2005), LMSs combine an array of administration and pedagogical tools to support the design and delivery of online learning environments. Although the online feel and appearance of the system can be customised, they claim that “LMSs are not pedagogically neutral technologies, but rather through their very design, they influence and guide teaching” (p. 27). Vovides et al. (2007) point out that current LMSs incorporate a selection of tools that allow instructors to a certain degree to modify and personalise the look and feel of the online learning space. In another study Alario-Hoyos and Wilson (2010) analysed the integration of external third-party tools in LMSs such as Facebook, AutoCAD, GIS and DrGeo, and found that the ability to extend existing LMS platforms enhanced the flexibility and customisation of systems, as well as supported a wider range of learning situations. Griffin and Rankine (2010) assert that “the design and on-going management of these online environments rest largely on the knowledge and skills of academic staff” (p. 505).

With LMS applications available today, it is really simple to get course content online. But as previously described in Category 1, online content must be appropriately designed to engage the student and promote learning. This is why several universities and colleges, including UNISA, implement a team approach to curriculum and learning development. For Oblinger and Hawkins (2006), the design and delivery of online courses require several varied skills - skills that are not likely to be found in one particular person. Although academics who teach the programme are the ultimate ‘owners’, as part of a team, they are required to work collaboratively with curriculum and course designers, multimedia and software developers, language specialists, tutors, etc. (UNISA, 2008, p. 4). Henry and Meadows (2008) state that “the expertise involved in developing excellent online courses is not optional; it is essential” (para. 33).

The taxonomy described above highlights LMS affordances, particularly as a powerful teaching and learning tool. The next section deals with how the affordances of a current institutional LMS (myUNISA) are being used to support ODL.

2.5 HOW THE AFFORDANCES OF A CURRENT INSTITUTIONAL LMS ARE BEING USED TO SUPPORT ODL

In 2006, UNISA adopted Sakai open source software to add to an already wide range of learning resources being used (e.g. videoconferencing, satellite broadcasts, DVDs). Branded as myUNISA, the LMS’s capabilities are varied and include all the teaching, learning and communication tools considered standard to most LMSs (Simonson, 2007). Essentially, myUNISA operates as a primary “engine” for the online provision of all administrative, communication and support services, including application, registration and library as well as teaching and learning activities (SAKAI, 2016). Several institutional policies, including the ODL policy, have been introduced to stimulate the deployment of myUNISA activities to encourage educators to use and integrate and have an online presence on myUNISA for teaching and learning.

Most modules have been assigned a myUNISA module site on the internet. These form an integral part of the teaching and learning environment at UNISA. One of the distinctive features of myUNISA is that it is continually being customised to provide students with personalised teaching and learning in addition to administrative and support services. The myriad of tools available on myUNISA range from simple content creation, document uploading and resource delivery, to more sophisticated collaborative tools such as discussion forums, blogs and wikis, in addition to online assessment tools (assignment submission, automated online marking, and e-portfolios).

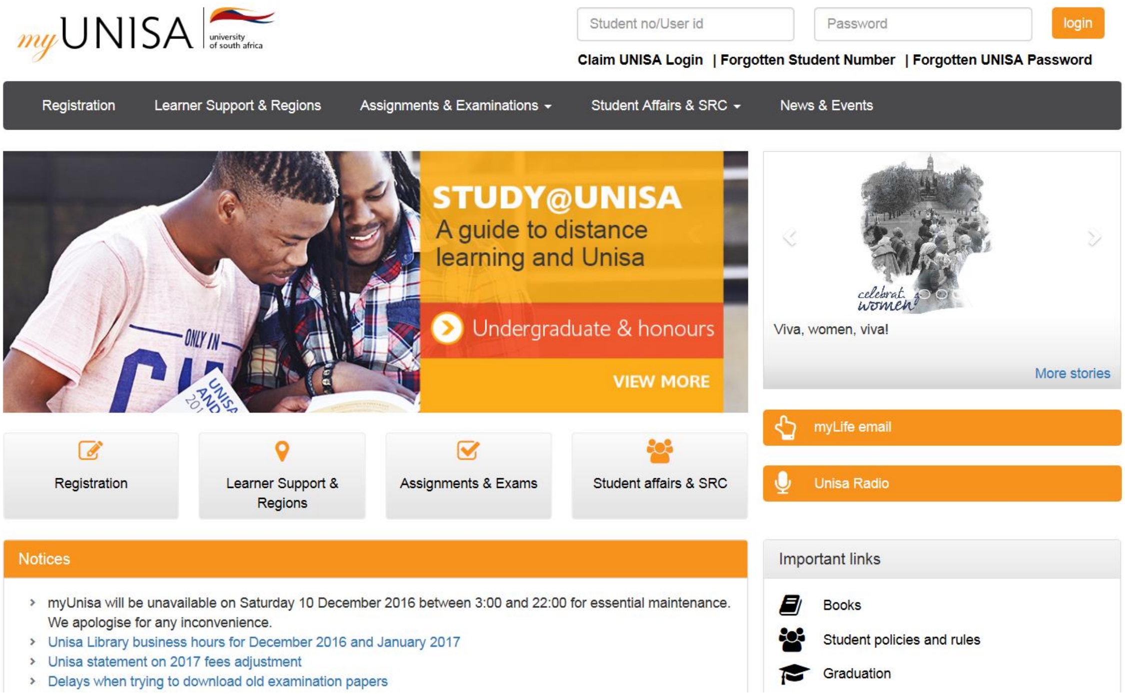

Figure 4: *Homepage of myUNISA portal where users log on with a unique username and password to access specific course or module sites*

Moreover, myUNISA is a potentially powerful tool and represents a promising strategy for UNISA to give expression to its ODL agenda. This necessitates overcoming barriers of access to learning experienced by previously disadvantaged groups in South Africa, i.e. blacks, women, people with disabilities, scattered rural populations, the poor and adults who have missed out on opportunities to access higher education. A key property of the myUNISA LMS is its ability to overcome barriers of time and space. With internet connectivity, students with any device can log on with a unique username and password (see Figure 4) and instantaneously and conveniently access learning content, administration and communication resources and get online help from tutors 24/7, 7 days a week (Black, Beck, Dawson, Jinks, & DiPietro, 2007).

While studying at a distance, UNISA students no longer have to rely solely on print-based learning materials that would ordinarily be posted to them. As an alternative, myUNISA provides students with access to a plethora of learning resources, e.g. electronic study guides and tutorial letters, and links them to supplemental course-related information in an array of formats, e.g. audio and video, animations and simulations, including access to OERs that are freely available at anytime, anywhere from across the globe (Unwin et al., 2010). As an institution of higher learning, UNISA is concerned with how best to increase flexibility of learning to provide for the needs of diverse students. Flexible learning at UNISA includes using myUNISA to access remote or online study that can take place anywhere, any time.

In addition, changing practices as a result of myUNISA have made considerable improvements possible, such as reducing or even eliminating the procrastination of interaction previously inherent in distance education. Regardless of geographical location or time zone, myUNISA makes it possible for students to link to the institution and to interact with the lecturer, electronic content and the LMS interface more frequently, as well as connect with other students. Opportunities for myUNISA-mediated collaboration and engagement among students represent an important function in distance education as it "is often perceived and experienced as a lonely way to learn" (Anderson, 2008, p. 222).

UNISA also requires all teaching and learning interventions, whether ICT based or not, to be carefully designed and implemented. Mindful planning of learning materials and how the myUNISA LMS might be designed and incorporated to provide supplementary materials and electronic support is therefore extremely important. This means that a multitude of design elements (see Figure 5) must be deliberately considered and built in to the learning environment if they are meant to help educators facilitate, guide and foster active and engaged learning experiences. This condition is consistent with the South African Qualifications Authority (SAQA) (2005), which claims that learning design involves more than just content; instead, it constitutes the plan intended to offer students a fair opportunity to attain the required learning outcomes. This approach to the design and delivery of ODL programmes tries to promote access, quality and support with the expectation that students can succeed.

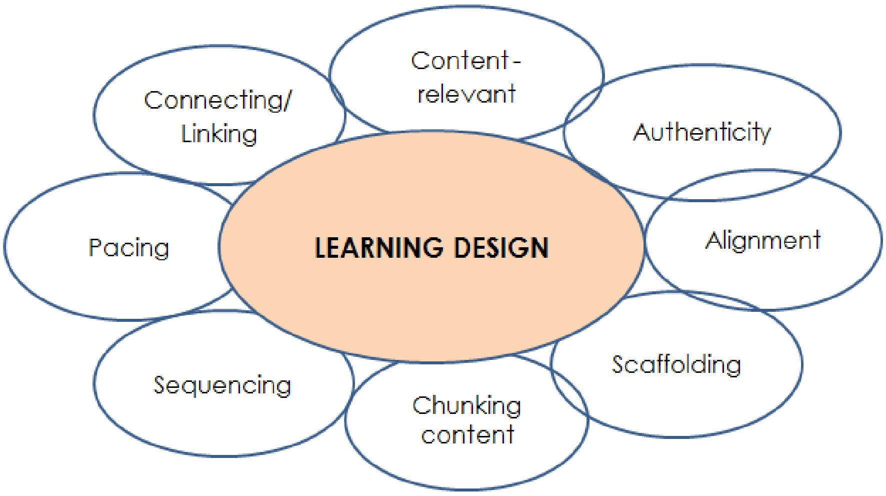

Figure 5: *Elements for effective learning design (adapted from Collins, 1996, and SAQA, 2005)*

In view of the above, the researcher can therefore conclude that myUNISA LMS affordances can meaningfully support ODL teaching and learning. However, other researchers who examined the application of LMSs found that while educators are using LMSs, many challenges are encountered. Some of the key constraints and challenges associated with the pedagogical integration of LMSs are explored in the next paragraphs.

2.6 CHALLENGES ASSOCIATED WITH THE PEDAGOGICAL INTEGRATION OF LMSs

While the unique in-built functionalities of LMSs offer exciting new possibilities for teaching and learning, they pose challenges as well. Black et al. (2007) suggest that the integration of an LMS in the teaching and learning environment is inherently complex for educators. Czerniewicz and Brown in Mlitwa (2007) attribute this complexity to educators who feel they do not have sufficient time available to engage with the system and pedagogy. Morgan (2003) also argues that the sense of LMS application is that it is "time-consuming, inflexible, and difficult to use. [Users] resented the time required to load and reload course materials" (p. 3).

In spite of the large application and growth of LMSs, Bri, García, Coll and Lloret (2009) found that several of the available tools are not being utilised as lecturers lack knowledge of LMSs. Vovides et al. (2007) claim that despite the potential of LMSs to scaffold learning, the integrated features of LMSs that make multimedia representations possible are being underutilised. They report that many educators still represent the content in text format only and that “this traditional working method does not promote student interactivity, engagement with the content, or learning” (p. 67).

Additionally, Vrasidas (2004) points out that LMSs are being utilised in very inefficient ways. He states that educators often use LMSs to upload content online without employing any sound pedagogic philosophies. This, he says, is largely as a result of educators’ lack of knowledge and skill to design and teach online courses. Singh et al. (2010, p. 299) describe the application and use of appropriate online tools as an overwhelming chore for many educators. They attribute this mainly to educators’ perceptible lack of knowledge of the interactive features of LMSs and of the online tools.

Moreover, Cant and Bothma (2011) discovered that while some ODL educators hardly ever use the institutional LMS, others use it to a limited extent only. Their findings offer numerous reasons as to why educators feel challenged: (1) not sufficiently trained in the use of the LMS, (2) lack of practical hands-on experience, (3) lack of availability of time to spend on the LMS, (4) see no value in applying the LMS, and (5) limited knowledge and not being aware of the full capabilities of the LMS.

In light of these challenges Black et al. (2007) assert that it is essential that educators develop a certain breadth and depth of knowledge that will support a balanced understanding of the issues relating to the adoption of LMSs. Comparable research by Coates et al. (2005) recommends that educators, regardless of experience and context, need to become skilled in different forms of online communication and conversant with the latest flexible learning provision, and even fabricate new online personalities as well as acquire an understanding of just-in-time learning. Chua and Jamil (2012) emphasise that educators need to develop a professional knowledge base, including technology knowledge, which is an essential skill for technology integration in teaching and learning. Mishra and Koehler (2006) propose that educators require TPACK to be able to teach successfully using technology.

Having discussed some of the key challenges associated with the pedagogical integration of LMS, it has become evident that educators need to not only be proficient in LMS usage, i.e. knowing about the inherent features of the LMS, but also to know how and when to integrate LMS tools appropriately for teaching and learning. This means having to purposefully think and act with regard to integrating LMS as an instructional tool. The next section presents TPACK as an analytical theoretical framework that will be used as a lens to determine what ODL educators need to know in order to integrate an LMS appropriately as a teaching tool.

2.7 THE TPACK FRAMEWORK

In order to identify and better understand the specialised bodies of knowledge educators need for making pedagogical choices with regard to integrating LMSs as a teaching tool, this study engaged and adapted Mishra and Koehler's technological pedagogical and content knowledge framework (2006).

The idea that educators possess specialised bodies of knowledge, a category of professional knowledge distinguishable from other knowledge constructs, is not new. Mishra and Koehler (2006) credit Shulman (1986; 1987) as being the first to introduce the idea of pedagogical content knowledge (PCK) by engaging in the study of knowledge growth in teaching. As shown in Figure 6, the construct of PCK comprises content knowledge and pedagogical knowledge and is representative of the kind of knowledge that separates the expert teacher in a particular content area from the content expert. Shulman (1986) asserts that historically, content knowledge and pedagogical knowledge were dealt with in isolation as independent knowledge constructs. He is of the opinion that crucial to these knowledge structures is the consideration of the relationship between subject matter content and pedagogy. Educators' knowledge structures progressively evolve and change over time. Educators gradually develop essential skills to transform subject matter, acquiring the techniques to represent it and to make it accessible to students (Shulman, 1986).

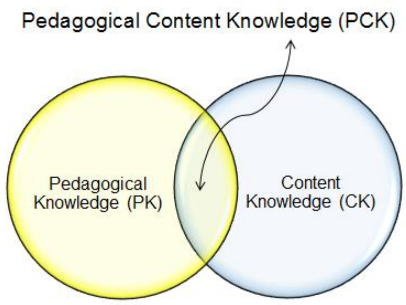

Figure 6: *Pedagogical Content Knowledge (adapted from Shulman, 1986)*

Shulman incorporated PCK as a distinctive category of knowledge within the knowledge base of educators needed to facilitate learning. According to him, educators' knowledge base includes three categories of content knowledge: (a) subject matter content knowledge, (b) PCK and (c) curricular knowledge together with four additional categories, namely (d) pedagogical knowledge, (e) knowledge of students and their characteristics, (f) knowledge of educational contexts, and (g) knowledge of educational goals and purposes (Shulman, 1987). Contained in Shulman's description of curricular knowledge (1986) is an understanding of the various tools and materials used for instruction including "the alternative texts, software, programs, visual materials, single-concept films, laboratory demonstrations, or 'invitations to enquiry'" (p. 10).

Despite this notion, Mishra and Koehler (2006) describe Shulman's PCK construct as limiting, not explicitly examining digital technology and its relationship to pedagogy, content and students. According to Mishra and Koehler (2006), PCK in its initial state does not overtly explain how educators utilise the affordances of technology to transform content and pedagogy for students. Nowadays, with the continual growth and application of LMSs as the preferred technology in ODL, Shulman's PCK construct needs to be expanded "to capture some of the essential qualities of teacher knowledge required for [LMS] integration in teaching" (Mishra & Koehler, 2006, p. 1017).

In recent years, increasing attention has focused on the issue of what educators need to know to be able to teach successfully using an LMS (Arinto, 2013; Lorusso & Sisto, 2013). What has become evident is that simply introducing an LMS in an ODL context will not automatically lead to effective teaching with the LMS. Clark (1983) in (Anderson, 2008) claims that technologies are merely vehicles that deliver instruction and cannot in and of themselves influence teaching. Instead, as a powerful tool, technology can be used to reconstruct the subject matter from the educator's knowledge and understandings of the content into content for instruction. Bates (1997) states that "the promise of new technologies does not necessarily lead to open learning, nor does it guarantee that technology will be used in these ways" (p. 94). Rather, it is the deliberate and intelligent pedagogical ways in which technology is used, and not the technology itself, that supports open learning. In other words, teacher knowledge is needed.

Mishra and Koehler (2006) built on Shulman's main idea of PCK, expanding it to incorporate an additional element, i.e. technological knowledge, which has brought about the representation of new constructs (technological pedagogical knowledge or TPK, technological content knowledge or TCK, etc.). Thus, the TPACK construct is conceptualised as a complex situated form of knowledge deeply embedded in the interactions of technology, pedagogy and subject matter content. It is argued that TPACK, as a theoretical tool, assists with identifying the composite knowledge concepts particularly as they relate to the process of LMS integration.

The model identifies and considers three main components of educators' knowledge: technology knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK). Each of these knowledge constructs, as shown in Figure 7, are scrutinised in isolation but in addition, the model also emphasises the importance of the intricate relationships, interactions and overlapping that exists between these constructs as they come about within a particular context (Koehler & Mishra, 2009). The TPACK framework highlights and differentiates between seven knowledge constructs, discussed below.

TPACK Constructs

2.7.1 Technology Knowledge (TK)

Technology knowledge is used to define knowledge of everyday conventional technologies such as pen and paper, books, chalk, blackboards and overhead projectors, as well as knowledge of the latest technologies such as computers, the internet and digital video (Koehler & Mishra, 2005b; Mishra & Koehler, 2006; Schmidt et al., 2009). It encompasses knowledge of the hardware and software, knowing how to manipulate and apply particular tools and the ability to troubleshoot technical problems as they arise (Angeli & Valanides, 2009; Mishra & Koehler, 2006). While basic TK may simply imply an awareness of the existence of particular tools, Koehler and Mishra (2009) define a more advanced mastery of technology necessary for information processing and communication. For them, fluency in educational technology means knowing how to operate technology and being able to discern when technology can support or constrain the attainment of educational goals (Cox, 2008; Koehler & Mishra, 2009).

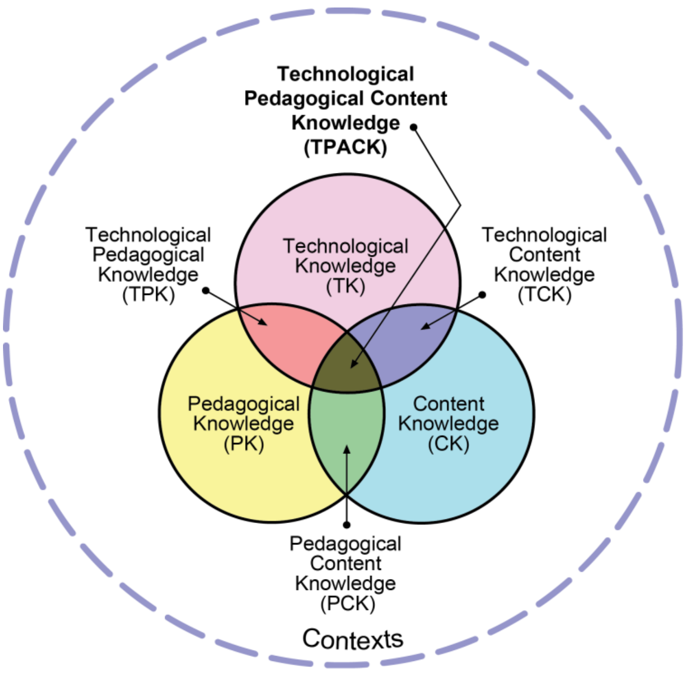

Figure 7: *Technological Pedagogical and Content Knowledge (TPACK) framework (reproduced by permission of the publisher, © 2012 by TPACK, 2016)*

2.7.2 Pedagogical Knowledge (PK)

Pedagogical knowledge describes "the collected practices, processes, strategies, procedures, and methods of teaching" that promote student learning (Koehler & Mishra, 2005b, p. 133). PK also incorporates knowledge about the aims of instruction, organising and managing the teaching space(s), designing and implementing study material/lessons, as well as strategies for assessing and monitoring students' understanding (Koehler & Mishra, 2005b; 2009). Educators who demonstrate an understanding of how students learn are knowledgeable about the "cognitive, social, and developmental theories of learning and how they apply to students" and show evidence of PK (Mishra & Koehler, 2006, p. 1027). Even though not explicitly linked to any specific technology, imbued in PK is the use of various pedagogical strategies such as scaffolding, motivating students and checking for understanding and misunderstanding (Angeli & Valanides, 2009).

2.7.3 Content Knowledge (CK)

Content knowledge refers to knowledge about "the subject matter that is to be learned or taught" (Koehler & Mishra, 2005b, p. 133) and represents "the amount and organization of knowledge per se in the mind of the teacher" (Shulman, 1986, p.9). CK characterises an awareness of the curriculum and the ability to recognise how particular content connects to other courses/subject areas. It entails a grasp of and familiarity with the facts, concepts, theories, techniques and procedures, as well as an understanding of the rules for determining what constitutes legitimate knowledge in a given subject domain. CK furthermore implies being conversant with the full selection of materials for that instruction, i.e. alternative text, software applications, visual aids and demonstrations, and understanding why specific topics taught in a given discipline are deemed central (Shulman, 1986). Educators who lack these understandings can misrepresent the subject matter and misinform and mislead students (Mishra & Koehler, 2006).

2.7.4 Pedagogical Content Knowledge (PCK)

As discussed earlier, the construct of PCK was popularised by Shulman (1986) to emphasise the blending of pedagogy and content. PCK represents a particular kind of content knowledge and characterises an understanding that "goes beyond knowledge of subject matter per se to … subject matter knowledge for teaching … that embodies the aspects of content most germane to its teachability" (p. 9).

Mishra and Koehler (2006) concur with Shulman's conceptualisation of PCK as "knowledge of pedagogy that is applicable to the teaching of specific content" (p. 1027). Key elements in Shulman's conceptualisation of PCK are educators' knowledge of the likely preconceptions and misconceptions students of different ages and diverse backgrounds might bring to the learning experience. This includes an understanding of the corrective conditions necessary to reorganise students' comprehension to overcome misunderstandings about the content, as well as knowledge of the full range of treatments and interventions available for addressing misconceptions and unique circumstances and fostering meaningful learning.

Included in Shulman's conception of PCK is the transformation of content for teaching. He claims that "comprehended ideas must be transformed … if they are to be taught … [a] process wherein one moves from personal comprehension to preparing for the comprehension of others" (1987, p. 16). This transformation necessitates a blend or arranging of several processes, including the mindful selection and preparation of content for teaching, knowledge of instructional strategies that fit the content and decoding and knowing how to flexibly adapt and tailor the content to meet the diverse characteristics of students (e.g. age, language, gender, culture, prior knowledge and abilities) and fit the needs of specific individuals or groups of students (e.g. disabilities). In addition, PCK involves understanding why students find certain concepts/topics easy or difficult to learn, and entails knowing how to structure, chunk and sequence instructional material, e.g. design and pace learning material/activities for better teaching (Shulman, 1987).

Moreover, PCK necessitates thinking through the content – contemplating and identifying alternative techniques to represent the content in multiple ways that make it understandable to students by using "powerful analogies, illustrations, examples, explanations, and demonstrations" (Shulman, 1986, p. 9). Educators who know how to establish links between students' prior knowledge, real-life experiences and the content, and who are skilled in making connections between various concepts, topics and modules within the same or other subject areas demonstrate evidence of PCK (Koehler & Mishra, 2009; Mishra & Koehler, 2006; Shulman, 1986). PCK is of particular interest as it represents unique domains of teacher knowledge for teaching and is regarded as "the category most likely to distinguish the understanding of the content specialist from that of the pedagogue" (Shulman, 1987, p. 8).

2.7.5 Technological Pedagogical Knowledge (TPK)

TPK refers to knowledge about (content-free) pedagogical strategies and understanding how teaching might be transformed as a consequence of using certain technologies (Koehler & Mishra, 2005b; 2009; Mishra & Koehler, 2006). TPK aimed at supporting pedagogical goals simultaneously infers (a) an awareness of the range of tools that exists, (b) knowing when and how to deliberately select and apply tools fit for a specific instructional purpose, and (c) being conversant with the pedagogical constraints and affordances as they relate to particular teaching designs and techniques. For example, educators who can decide on suitable software/tools to foster collaboration and maintain and monitor student records, class marks and online discussions display evidence of TPK (Koehler & Mishra, 2009; Mishra & Koehler, 2006). They suggest that TPK becomes critical especially when repurposing web-based technologies for pedagogical purposes. Modifying and customising technologies for teaching require adaptive, creative, forward-looking educators, who are ready to go beyond familiar uses of technology.

2.7.6 Technological Content Knowledge (TCK)

TCK describes the knowledge associated with being a subject specialist (free of pedagogical strategies) and understanding how the nature of the content can be transformed by applying technology (Koehler & Mishra, 2005b, p. 134). It refers to an awareness of the range of appropriate software and tools that can support the representation of particular content, knowing how particular technologies can support and hamper the kinds of content that can be illustrated and being able to recognise how certain content choices can restrict the kinds of technology that can be applied (Koehler & Mishra, 2009, p. 65). For example, the latest web-based technologies, including simulation and subject-specific software such as Geometer Sketchpad, AutoCAD, GIS and the use of LMSs, make virtual reality accessible to students. Through imitating and mimicking phenomena, simulation software transforms the content. Not only does technology afford students newer and more varied forms of representation (e.g. text, sound, colour, graphics and models), but it also offers greater flexibility in navigating across multiple representations. Likewise, when students actively engage, enacting both on and with technology, the very nature of learning is being transformed (Mishra & Koehler, 2006).

2.7.7 Technological Pedagogical Content Knowledge (TPACK)

TPACK is defined as a deep understanding of the complexities and nuances that underlie the pedagogical integration of technology and characterises good teaching with technology. It is described as a situated form of knowledge, a distinct class of knowledge that emerges from the interactions among and between technology, pedagogy and content (Koehler & Mishra, 2009). It also denotes the flexible and mindful linking and navigating between technology, pedagogy, content, students and the context and understanding the dynamic, transactional relationships between all the components (Koehler & Mishra, 2005). Moreover, Mishra and Koehler (2006) define TPACK as:

> *an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones.* (p. 1029)

Koehler and Mishra (2005a; 2005b) claim that TPACK can be developed. Teachers can explicitly learn how to integrate technology for teaching. However, this necessitates teachers to experience, as students, the varieties of learning environments that can facilitate and enhance learning through purposeful application of technology. They maintain that TPACK can function as an analytical lens for researchers for studying the development of teacher knowledge about the integration of technology for teaching.

Additionally, they suggest that the TPACK framework can be used as a conceptual lens to help identify the constructs mentioned above.

Accordingly, ODL educators may require more advanced knowledge when integrating an LMS as a teaching tool. Griffin and Rankine (2010) argue that "the design and ongoing management of these environments rest largely on the knowledge and skills of academic staff" (p. 505). Therefore, this study suggests that ODL educators need TPACK, as presented from the ideas of Koehler and Mishra (2005a; 2005b; 2009); Mishra and Koehler (2006), to teach effectively using an LMS. Corresponding with the development of TPACK, this study introduces the LMS-TPACK framework for assessing ODL educators' knowledge as it relates to LMS-augmented instruction.

2.8 CONCEPTUAL FRAMEWORK AND DEVELOPMENT

From TPACK to LMS-TPACK

This section presents the conceptual framework used in this study. The main objective of this research was to develop a new instrument for assessing ODL educators' perceived LMS-TPACK. The results were used to test the validity and reliability of the instrument.

The LMS-TPACK model is theorised as a strand of TPACK. The PCK construct of Shulman (1986; 1987) and Mishra and Koehler (2006), described earlier, functions as an initial conceptual basis for LMS-TPACK. Thus, as represented in Figure 7, LMS-TPACK consists of the blending of contributing TPACK knowledge bases, namely (1) technological knowledge (in this instance limited to LMS knowledge), (2) pedagogical knowledge and (3) content knowledge.

In developing the conceptual framework, it is argued that knowledge about an LMS cannot be treated as though it is context-free. Instead, effective LMS-based teaching requires an understanding of how the LMS relates to pedagogy, content and the educational context. Thus knowledge about the ODL context in which teaching and learning takes place was added, taking into account research findings from previous studies with ODL educators (Arinto, 2013; Cant & Bothma, 2011; Lorusso & Sisto;

2013). These findings suggest that educators, when teaching with an LMS, draw upon their knowledge and experiences relating to the intricacies and workings of the distance learning context, including the policies and principles that govern ODL such as focusing on removing barriers to access learning, fostering student centredness and being aware of the wider national and institutional educational goals. Knowledge of ODL contextual conditions also comprises an understanding of educators' personal thoughts of what makes for 'good' distance teaching – that is, what can facilitate or inhibit effective distance teaching.

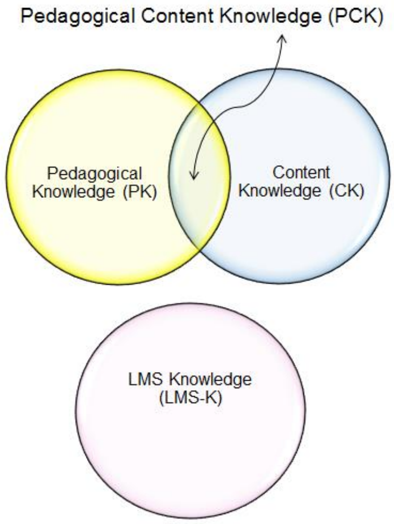

Figure 8: *PCK constructs as an initial conceptual basis for LMS-TPACK*

Briefly, in the initial LMS-TPACK model, depicted in Figure 8, are the following:

LMS knowledge (LMS-K) generally encompasses knowledge about the LMS, i.e. knowing how to manipulate and apply a variety of LMS-based tools and the ability to troubleshoot technical problems as they arise.

Pedagogical knowledge (PK) refers to a wide range of strategies, practices and methods of teaching that facilitate student distance learning as it applies generally across different subject domains.

Content knowledge (CK) includes knowledge of the curriculum, facts, concepts, theories, techniques and central topics, and the ability to select content for teaching that meets the requirements and standards of accredited professional bodies and broader educational goals.

Similar to the conceptualisation of Shulman (1986; 1987) and Mishra and Koehler, *pedagogical content knowledge (PCK)* emphasises the blending of pedagogical and content knowledge. It includes knowledge of the students and their characteristics, the likely preconceptions and misconceptions students bring to the learning situation and an understanding of the full range of materials for instruction or tools of the trade, e.g. different texts, visual and audio tools. Extending PCK to incorporate LMS knowledge has brought about the representation of three additional new constructs, i.e. LMS-PK, LMS-CK and LMS-TPACK, as represented in Figure 9.

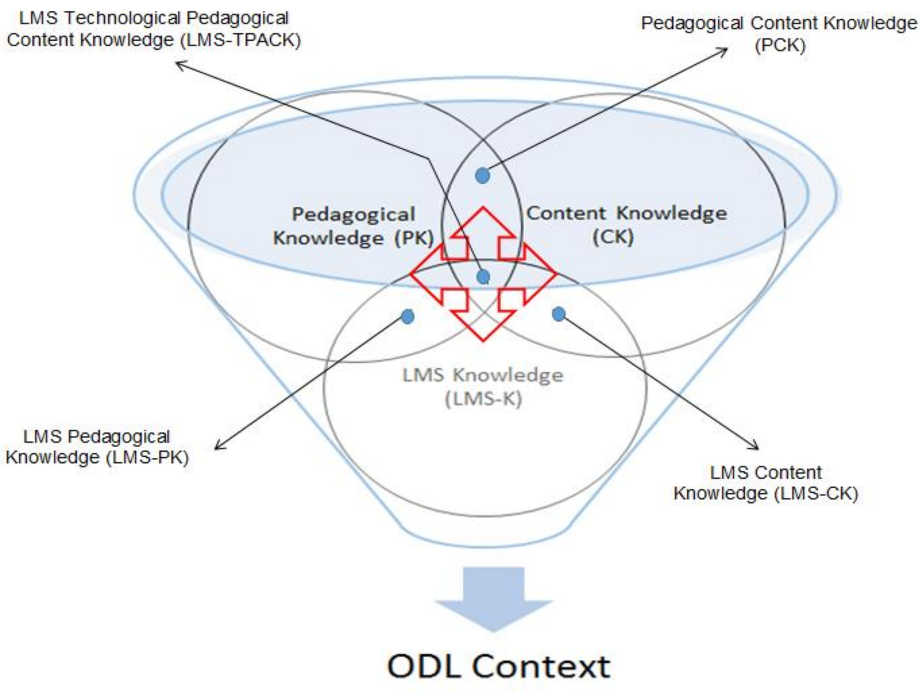

Figure.9: *LMS-TPACK*

LMS pedagogical knowledge (LMS-PK) refers to knowledge (content-free) about the tools and functions of the LMS and understanding how they might be used for instructional purposes, such as being able to use the LMS to design multiple forms of feedback online. Examples are incorporating announcements, automated SMSs or comments in the grade book.

LMS content knowledge (LMS-CK) describes the knowledge associated with being a subject specialist (free of pedagogical strategies) and understanding how the LMS can be used to teach and bolster the content and how the nature of the content can be transformed. For example, running an online video or simulation on the LMS is different from reading printed text.

LMS technological pedagogical content knowledge (LMS-TPACK) can thus be described as the manner in which knowledge about LMS tools, their pedagogical affordances, pedagogy, content, students and the ODL context are synthesised into an understanding of how to represent and formulate particular concepts. This entails knowing how to use the LMS to provide multiple alternative forms of representation, making it more accessible to students, having knowledge of instructional strategies (i.e. scaffolding, chunking, pacing, etc.) and using the LMS in any one or combination of ways to teach content, having knowledge of difficult or easy concepts and using the LMS to provide remedial actions and to support students who encounter learning difficulties, knowing students' prior knowledge and experiences and using the LMS to link to existing knowledge, context and the new knowledge to be learnt, making the associations explicit.

LMS-TPACK is conceptualised as a unique body of knowledge that makes an ODL educator knowledgeable and competent to design and teach in an LMS environment. The researcher is of the opinion that an LMS is not simply a tool for disseminating content, but that it can be used as a cognitive tool to provide students with opportunities to engage in a flexible blended learning environment. Finally, LMS-TPACK is viewed as being an emergent form of knowledge that is constantly developing and evolving over time. The red quad arrow in Figure 9 suggests that with years of teaching experience educators' LMS-TPACK can expand and change as they become more experienced and competent in teaching with the LMS. On the other hand, the blue knowledge funnel provides a visual representation of an educator's journey. The wide top illustrates the mix of various forms of knowledge and symbolises the connection and unity that emerges among and between the LMS, pedagogy and content. The tube or pipe-like structure is used to guide the knowledge growth process from initial awareness to LMS-TPACK (the blue arrow emerging through the small opening) in an ODL context.

2.9 MEASUREMENT OF TPACK

Since the work of Mishra and Koehler (2006), educational researchers worldwide have expressed interest in the TPACK framework. While numerous efforts have increasingly turned to measuring TPACK, researchers have pointed out the need to develop valid and reliable assessment methods and instruments for measuring TPACK to better understand teachers' knowledge and inform professional development approaches. Current surveys tend to focus on measuring pre- and in-service teachers, reporting their perceptions on or competence in TPACK, focused on specific technology (Angeli & Valanides, 2009; Lee & Tsai, 2010), pedagogy (Chai et al., 2011) and context (Archambault & Barnett, 2010; Arinto, 2013). To date, a wide range of instruments have been developed, i.e. open-ended questions, performance, interviews, observations and self-report surveys. The focus of this next section is restricted to the analysis of the development and application of self-report survey instruments, which have become a popular means to assess teachers' TPACK (Dinh, 2013; Ronau, Rakes, & Niess, 2012).

Mishra and Koehler (2006) were the first to construct a survey instrument to measure TPACK. The survey, consisting of 35 items (33 Likert scale items and 2 short-answer questions), was administered to 4 faculty members and 13 students, who completed the survey twice, once at the beginning and once at the end of the semester. They embarked on tracking changes in teachers' perceptions in the level of TPACK knowledge at both an individual and group level. Although they found the subjects changed from viewing technology, pedagogy and content as autonomous constructs, their results are not generalisable to other content areas and contexts as the survey was designed exclusively to document specific course experiences (Schmidt et al., 2009). Moreover, they failed to report on the reliability and validity measures.

In an effort to develop a more reliable and valid measure of TPACK; Schmidt et al. (2009) created an online survey entitled "Preservice Teachers' Knowledge of Teaching and Technology". The initial 75-item survey assessed all seven TPACK subscales of

124 elementary and early childhood preservice teachers with regard to different content areas. Several steps were employed to maximise content validity, i.e. literature review, drawing from existing instruments and having experts review the item pool. Internal consistency reliability (using Cronbach's alpha) was calculated for each TPACK construct and ranged from .75 to .92. Owing to the relatively small sample size (n = 124), partial exploratory factor analysis (EFA) was performed only on CK, PK, PCK, TCK and TPACK.

In Taiwan, Lee and Tsai (2010) surveyed 558 elementary to high school teachers. They created a new instrument called Technological Pedagogical Content Knowledge-Web (TPCK-W) to measure teachers' perceived self-efficacy in TPCK-W and assess their attitude toward web-based teaching. Their initial questionnaire contained 6 scales, i.e. web-general, web-communicative, web-pedagogical knowledge (WPK), web-content knowledge (WCK), web-pedagogical-content knowledge (WPCK) and attitudes toward web-based instruction. Their factor analysis produced five factors, with WPK and WPCK scales loading as a single factor. The overall internal consistency was .96. In addition, correlation analysis examined the relationships between teachers' perceived self-efficacy in TPCK-W, their attitudes towards web-based teaching, web experience, age and teaching experience.

In a further attempt, Chai et al. (2011) developed a pedagogy-specific instrument and explored how the contextualisation of items in a TPACK instrument (TPACK for Meaningful Learning) enhanced construct validity. The online survey adapted from Schmidt et al. (2009), Koh, Chai and Tsai (2010) and Chai, Koh and Tsai (2010) represented all seven TPACK constructs. The initial instrument contained 36 items and was administered to 336 Singaporean primary and secondary preservice teachers. Given the context, CK items were separated into two constructs, i.e. first teaching subject and second teaching subject. PK items were designed to focus on self-directed and collaborative learning, while TPK gave attention to constructivist teaching methods supported by technology. The EFA confirmed the eight constructs as put forward by the contextualised model. Internal consistency was calculated for each TPACK construct and ranged from .84 to .94 and overall reliability, $\alpha = .95$.

Seeking to provide empirical evidence for the TPACK framework, an additional study was conducted by Shinas et al. (2013). These scholars used the survey of “Preservice Teachers’ Knowledge of Teaching and Technology” of Schmidt et al. (2009) to explore the existence of the TPACK constructs. Using the responses from 365 preservice teachers in the United States, EFA was conducted to isolate the constructs underlying the items on the validated instrument of Schmidt et al. (2009). Internal consistency for the 47 items measuring TPACK was found to be reliable, with Cronbach’s $\alpha = .94$, which was in line with the scores reported by Schmidt et al. (2009).

More recently, Pamuk, Ergun, Cakir, Yilmaz and Ayas (2015) developed a TPACK instrument to investigate relationships between the TPACK constituents and explore preservice teachers’ knowledge levels in the various TPACK components. Several steps were undertaken to ensure content and construct validity, including an extensive literature review and expert judgement. Data collection and data analysis were carried out in two phases. Firstly, with 147 preservice teacher responses, EFA was computed and reliability estimates calculated for each factor and the instrument. Secondly, data from 882 preservice teachers were analysed with a structural equation model. Reliability analysis revealed that each TPACK construct had a high alpha coefficient ranging from 0.76 to 0.95 and for the entire instrument $\alpha = .95$.

Generally, it appears that researchers are able to identify the seven TPACK factors with varying levels of specificity for the technology, pedagogy and content areas employed. Despite the popularity of TPACK research, Cavanagh and Koehler (2013) are apprehensive about the techniques being used in the measurement of TPACK. They suspect there are “several areas of theorizing and practice that are likely impeding the press for measurement” (p. 129). First are ambiguities about the epistemology of TPACK (how we know it exists). Second is the lack of precision relating to the objective of the measurement of TPACK. Third is the selection and application of measurement varieties and techniques. They regard measurement “as the optimal means of establishing the validity of theoretical frameworks and models” (p. 129). What is more, they suggest that researchers, by outlining measurement principles and techniques, can ensure a valid reliable measurement of TPACK.

2.10 SUMMARY

In this chapter the core terms that underline modern-day open, distance and e-learning were defined, including the notion of affordances. Central to this review were UNISA policy and conceptions that shape existing institutional teaching practice within the context of this study. Additionally, the literature reviewed LMS affordances for teaching and learning, how the pedagogical affordances of the myUNISA LMS are currently being used to support ODL and constraints associated with the pedagogical integration of LMS. Mishra and Koehler's TPACK framework was introduced. Furthermore, the conceptual framework was represented as a next step in the development of an assessment instrument as it relates to ODL educators' perceptions of knowledge and skills, i.e. their LMS, pedagogical and content knowledge for meaningful online teaching in a developing country, in a transitioning context. The main objective for reviewing earlier TPACK research was to assist the researcher with the development of a new instrument. In the next chapter, measurement development is explained, and the issues of validity and reliability are dealt with specifically.

CHAPTER THREE

MEASUREMENT DEVELOPMENT

3.1 OVERVIEW

A primary objective of this study was to develop a new instrument for gauging in-service ODL educators' perceptions of their LMS-TPACK. A valid and reliable measurement instrument was vital to this scientific endeavour. Clark and Watson (1995) assert that trustworthy measurement ought to be a chief goal of sound scientific research. They claim that valid measurement "represents a key element in differentiating psychology as a science from other, nonscientific approaches to the analysis of human behaviour" (p. 310). McMillan and Schumacher (2010) define measurement as the practice of assigning numbers to things or events with the aim of uncovering the differing degrees of the trait being assessed. DeVellis (2003) sees measurement as a necessary pursuit of science, that as scientists we often acquire knowledge about people, entities, occurrences and processes by observing and by quantifying them. He recommends that we "measure the things in which we have a scientific interest" (p. 2).

Educational research often strives to describe or measure abstract concepts, also known as constructs. Cronbach and Meehl (1955) describe a construct as "some postulated attribute of people, assumed to be reflected in test performance" (p. 138). Creswell (2012) defines a construct as "an attribute or characteristic expressed in an abstract, general way" (p. 114). For example, educators' perceptions of conceptual constructs such as LMS-K, CK, PK and LMS-TPACK derived from theory cannot be directly observed or measured. This is due to the latent rather than manifest nature of various abstract constructs or phenomena. Latent variables, more commonly referred to by quantitative researchers as latent constructs or factors, are "variable rather than constant – that is, some aspect of it, such as its strength and magnitude, changes" (DeVellis, 2003, p. 14). In other words, they can vary with regard to time, place, persons, or combinations of these factors or several other factors.

In an attempt to reveal theoretical constructs, a scale as a measurement instrument serves as a means of collecting data when direct observation is not adequate. DeVellis (2003) maintains that in cases in which we are unable to depend on behaviour as an indicator of abstract phenomena, it can be helpful to evaluate and infer the construct(s) by way of a purposely constructed and accepted scale. He goes on to say that a common measurement instrument used when studying psychological and social constructs is the questionnaire, and the latent constructs of interest form part of the wider theoretical framework. In addition, a measurement instrument (e.g. questionnaire) is, as a collection of items or statements, intended to more accurately reveal the differing levels of the latent theoretical constructs, that is to say, they are scaled (DeVellis, 2003).

An essential constituent of objective scale development necessitates test developers to pay special attention to an instrument's validity and reliability. Clark and Watson (1995) mention that it has become routine practice that publishable assessment instruments are expected to be valid and reliable. DeVellis (2003) emphasises that if the issue of validity and reliability is disregarded, not only might a researcher "fail to exploit [the] theory" but might also "reach erroneous conclusions about a theory by misrepresenting what a scale measures". He explains a disturbingly common practice by researchers, which is to conclude that "some construct is unimportant or that some theory is inconsistent, based on the performance of a measure that may not reflect the variable assumed" (p. 11).

Likewise, it would be an oversight to assume that just because a new instrument has been developed, its results are valid. McMillan and Schumacher (2010) state that new locally developed instruments which have no prior use or reviews by other researchers need to be assessed. They stress that when researchers develop new measurement instruments, it is imperative to gather appropriate evidence for validity and reliability and to report such evidence.

3.2 VALIDITY

Validity is the judgement that an instrument (in this instance a self-report questionnaire) actually measures what it set out to measure theoretically. Messick (1995) defines validity as "an overall judgement of the degree to which evidence and theoretical rationales support the adequacy and appropriateness of interpretations and actions on the basis of test scores and other modes of assessment" (p. 741). McMillan and Schumacher (2010) concur with DeVellis (2003) that it is incumbent upon the test developer to demonstrate the appropriate evidence for validity in relation to the context in which the data are gathered.

Muijs (2004) lists three forms of validity: (1) content validity, (2) criterion validity and (3) construct validity. Content validity refers to "whether or not the content of the manifest constructs (e.g. items of a test or a questionnaire) is right to measure the latent concept that we are trying to measure" (p. 66). It is evident that there is an important function for theory in determining content validity. The test developer should sample a sufficient breadth of content to ensure that the content is well represented in the initial item pool (Clark & Watson, 1995). Similar to content validity, criterion validity too is directly related to theory. Muijs (2004) distinguishes between two types of criterion validity, namely predictive and concurrent validity. Predictive validity refers to whether or not the instrument used forecasts the results it was theoretically expected to. Concurrent validity refers to the degree to which the scores of a particular test correlate with those of a previously validated measurement for the same construct. Construct validity, on the other hand, is a somewhat more complex issue "relating to the internal structure of an instrument and the concept it is measuring" (Muijs, 2004, p. 68). This form of validity "relates to the question whether our measures follow the theoretical structure they are supposed to" (Muijs, 2011, p. 198).

McMillan and Schumacher (2010) recommend that multiple sources of validity evidence be used in scale development. Firstly, a comprehensive literature review ought to serve as a means for construct development and explore previous attempts that assess the target construct(s). Secondly, the focus group method can provide a fast cost-effective way to obtain content-rich information from a group of experienced practitioners and users (Kontio, Lehtola, & Bragge, 2004, p. 271). Thirdly, they recommend also having knowledgeable experts (e.g. people working in the content area) review the item pool. Fourthly, they suggest conducting a pre-test. Once a set of

test items have been developed, asking individuals to read and provide feedback on the wording and the clarity of the items can also be used to improve validity.
Furthermore, McMillan and Schumacher (2010) propose collecting validity evidence based on the internal structure of the questionnaire. This type of evidence is quantified when the correlations between items and differing parts of the instrument are consistent with the theory or its intended use. According to Clark and Watson (1995), EFA can play a crucial role in providing evidence, ensuring the validity of scales. EFA is a multivariate statistical technique commonly used in education to describe variability among observed variables in relation to the fewer unobserved variables known as factors. DeVellis (2003) regards this type of analysis as an essential tool in scale development. Not only does it allow the researcher to determine the number of factors underlying a set of items, but it can also provide insight into the nature of the latent constructs underlying the items.

Furthermore, EFA rather than confirmatory factor analysis (CFA) is recommended to ascertain the theoretical constructs underlying the items in the LMS-TPACK survey. Research evidence suggests that CFA may be a less desirable method for establishing the number of factors measured by a data set. For example, DeVellis (2003) found that model specifications might make little theoretical sense but can result in a statistically better model fit. Similarly, Saucier and Goldberg (1996) report that "because exploratory factor analysis provides a more rigorous replication test than confirmatory analysis, the former technique may often be preferred" (p. 35). In certain instances, only EFA is considered, to provide for stronger structural evidence than if the data were fitted to a specified model (Goldberg & Velicer, 2006).

3.3 RELIABILITY

In addition to determining an instrument's measure of validity, the focus of establishing an instrument's reliability is key. Field (2009) defines reliability as the degree to which an assessment tool (in this case a self-report questionnaire) can consistently reflect the construct(s) that it is measuring. In his opinion, "validity is a necessary but not sufficient condition of a measure" and an added condition is reliability - "to be valid the instrument must first be reliable" (p. 12). Likewise, Creswell (2012) maintains that stable consistent scores from an instrument are a fundamental condition for reliable research. His view is that test scores ought to be similar when researchers administer the same instrument multiple times at different points in time. If scores are not stable and consistent first, then they are not reliable and thus not valid. Hence, a goal of meaningful research ought to have measures that are both valid and reliable.

Measurement error in education relates to the consistency of scores - in other words, the degree to which scores are free from sources of error. In testing perceptual and theoretical constructs such as knowledge and skill, it is unlikely to ever produce a result that does not contain some degree of error (McMillan & Schumacher, 2010). Differences between what respondents' test scores indicate and their actual knowledge and capabilities are inevitable in testing. Test scores do not always accurately reflect reality, i.e. what respondents really know and can do. Creswell (2012) suggests that several contaminating factors can result in unreliable data, including ignorance, dishonesty and subjects who have guessed many responses. Another reliability problem is that "respondents may misunderstand a question or accidentally give a wrong response" (Muijs, 2011, p. 198). Field (2009) notes that by presenting reliability measures, test developers provide confidence that the measures are fulfilling their purpose for measurement error to be kept to a minimum.

There are several assessment techniques for determining the amount of error variance (or reliability) in test scores, for example test-retest, alternative forms, inter-rater reliability, and so on. According to DeVellis (2003), the manner in which researchers conceptualise and operationalise reliability varies and is contingent on the computational techniques employed. Each assessment technique is described in the form of a reliability coefficient, i.e. coefficient of stability, coefficient of equivalence, etc. The reliability coefficient represents "a correlation statistic" (McMillan & Schumacher, 2010, p. 179) and "demonstrates whether the test designer was correct in expecting a certain collection of items to yield interpretable statements about individual differences (Cronbach, 1951, p. 297). Since there are "constraints such as time, cost, and availability of the same subjects at multiple occasions, it [is] not always possible to take repeated measures or use alternate forms" (Netemeyer, Bearden, & Sharma, 2003,

p. 46-47). Thus, reference is made in the next paragraphs only to internal consistency reliability as a measurement technique.

Internal consistency is the most common measurement technique used to estimate scale reliability. Netemeyer et al. (2003) note that internal consistency involves a single administration of the test items to respondents, but it assumes availability of numerous items for measuring a given construct. Muijs (2004) explains that this form of reliability examines "how homogeneous the items of a test are or how well they measure a single construct" (p. 73). It also "relates to the extent to which all the variables that make up the scale are measuring the same thing" (Muijs, 2011, p. 217). Internal consistency reliability is usually determined by Cronbach's alpha.

Cronbach's alpha (α), or just alpha, is defined as "the proportion of a scale's total variance that is attributable to a common source, presumably the true score of a latent variable underlying the items" (DeVellis, 2003, p. 31). It represents a correlation coefficient (McMillan & Schumacher, 2010) that reports the extent a set of items designed to measure a single construct are interrelated (Netemeyer et al., 2003). Items comprising a scale (or subscale) which display high levels of interrelatedness suggest that the scale is internally consist. This signifies whether the test designer was accurate in anticipating a certain clustering of items to yield interpretable results about individual variances (Cronbach, 1951). The following rules of thumb for the interpretation of Cronbach's alpha values are recommended: > .9 – Excellent, > .8 - Good, > .7 - Acceptable, > .6 - Questionable, >.5 - Poor, < .5 – Unacceptable (George & Mallery, 2003).

3.4 SUMMARY

In this chapter, to ensure that quantitative data collected were sound, a number of key concepts that relate to measurement development were introduced. These concepts are grounded on methodical aspects that relate to validity and reliability. The important responsibility of the test developer to provide evidence for validity and reliability was highlighted. Lastly, to reiterate, reliability is a vital condition for validity. That is to say, scores cannot be valid without first being reliable. The next chapter outlines the research design and methodology, and the sequence of steps followed in scale development of the LMS-TPACK instrument are listed as recommended by Clark and Watson (1995) and DeVellis (2003; 2012).

CHAPTER FOUR

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

This chapter outlines the quantitative research approach and survey design and gives details of and defends the web-based self-report questionnaire employed in this study. The unit of analysis, the target population, sample size and sampling methods employed, including the ethical considerations, are specified. The steps followed in the scale development of the LMS-TPACK survey that was used for data collection are then described, including the data analysis and statistical techniques employed.

4.2 A QUANTITATIVE RESEARCH APPROACH

After the problem statement, purpose and research questions were formulated, the researcher decided on a quantitative research approach. Muijs (2004) defines quantitative research as a systematic empirical investigation used to explain quantifiable properties and phenomena and their relationships. The objective of quantitative research is to develop and employ statistical models, theories, hypotheses and/or research questions pertaining to phenomena. Vital to quantitative research is the process of measurement as it provides the fundamental connection between empirical observation and statistical expression of measurable relationships (DeVellis, 2012).

A central goal of this study was to create an empirically based instrument for measuring ODL educators' perceptions of their LMS-TPACK. Since the research was constrained by methodological difficulties concerned with measuring complex human traits such as knowledge and abstract theoretical constructs (variables which cannot be directly observed), quantitative measures were used to answer the research questions (DeVellis, 2003). Reliance on existing instruments of dubious applicability as presented in the literature reviewed in Chapter 2 was also a key rationale guiding the selection of a quantitative approach.

Generally, quantitative methods are intended to allow the researcher to explain phenomena by collecting vast amounts of numerical data and employing prescribed procedures (in particular statistics) to yield valid and reliable results (Muijs, 2004). The numerical data collected during this study were used to test for the validity and reliability of the new instrument. Furthermore, this study relied on ODL educators to provide an accurate account of their perceptions of their LMS-TPACK.

4.3 RESEARCH DESIGN

Research design denotes a researcher's plan of action for conducting the study. It includes the procedures in selecting subjects, research sites and data collection techniques. In other words, the research design specifies "which individuals will be studied and when, where, and under which circumstances" (McMillan & Schumacher, 2010, p. 102). The intention of a research design is to coordinate and implement the research to maximise the credibility of results that will be used to answer the research questions.

The current research used a survey design, defined by McMillan and Schumacher (2010) as one of several non-experimental designs used in measuring and describing phenomena. Creswell (2012) explains that in survey research, an investigator administers a survey instrument (in this case questionnaire) to a sample or to an entire population of individuals, collects numbered data and statistically analyses the data to describe trends about responses to questions to test the research questions. In this instance, the study intended to collect ODL educators' perceptions of their LMS-TPACK, and then statistically analyse and describe their responses to test for validity and reliability in the new instrument.

The strength of a survey design lies in its ability to offer an economical and efficient means of collecting large amounts of data from a body of educators. A cross-sectional survey design was used to gauge the perceptions of ODL educators' LMS integration knowledge. Creswell (2012) points out that cross-sectional survey designs permit the researcher to conduct large-scale assessments of educators at one point in time to examine current attitudes, perceptions or practices. This study analysed and described educators' responses to a survey instrument and tested for validity and reliability.

4.4 UNIT OF ANALYSIS

4.4.1 Target population

The target population in this study was all in-service ODL educators actively employed at UNISA during September/October 2014 who were asked to participate in this study. Only educators were chosen for the study since it was assumed that they had the necessary characteristics that were the focus of the study, namely LMS-TPACK. Data were collected from educators located on the Muckleneuk campus (Pretoria) and the UNISA Science campus (Florida) spread across six different colleges, namely Science, Engineering and Technology; Agriculture and Environmental Sciences; Accounting Sciences; Economic and Management Sciences; Human Sciences, and Law.

4.4.2 Sample size

In choosing subjects for this study, it was important to select a sufficiently large enough sample size from the population to attain credible results. Creswell (2012) points out that the sample size ought to be large enough to minimise sampling error and for the study's intended statistical analyses. Thus, to calculate the sample size required to test validity and reliability, various rules of thumb were applied. DeVellis (2012) warns against selecting a sample size too small. He asserts that with too few subjects "the pattern of covariance amongst the items may not be stable" and that "the sample may not represent the population for which the scale is intended" (p. 89). Comrey and Lee (1992) suggest that 300 subjects is a good enough sample size. The representative sample for this study consisted of 332 subjects who agreed to participate.

4.4.3 Sampling method

This study adopted purposeful sampling for the selection of its subjects. Purposeful sampling, a type of non-probability sampling method, is widely used in quantitative designs (McMillan & Schumacher, 2010). This method is used mainly to collect data from an entire population that have a particular set of characteristics, experiences, knowledge and skill (Moore & McCabe, 2005) intended to yield knowledge about the population under study for the purpose of statistical inference. Due to time constraints and cost effectiveness, subjects were selected on the basis of being readily available, using LMS and willingly volunteering. To identify subjects, the researcher obtained a staff list from the Department of Human Resources.

4.5 ETHICAL CONSIDERATIONS

McMillan and Schumacher (2010) caution that researchers should always be mindful to protect the welfare and rights of the subjects when conducting research. Since this study involved human subjects, the researcher ensured that all ethical and legal responsibilities were carried out before, during and after the research had been conducted. Clearance was obtained from the Wits and UNISA Ethics Committees, which granted permission to do the research (see Appendices A, B and C). Also, an initial email was sent informing subjects of the purpose and methodology of this study and formally asking them to voluntarily participate (refer to Appendix D). Upon accessing the online survey, implied consent was sought. That is to say, the researcher assumed that a person implicitly granted consent by clicking "NEXT" and thus agreed that they had accepted to participate in the survey. All information contained in the database was private and confidential and anonymity was maintained at all times. Furthermore, all the information/data gathered will be preserved for at least three years to allow for verification.

4.6 THE QUESTIONNAIRE

Although there are numerous TPACK survey instruments, instruments that measure LMS, ODL and TPACK variables jointly are limited in the literature (Archambault & Crippen, 2009; Arinto, 2013; Benson & Ward, 2013). Thus, a new web-based self-report questionnaire was developed and administered for this study. Creswell (2012) defines a web-based questionnaire as a survey instrument that is accessible on a computer and that consists of a series of questions, conducted over the internet and used for the purposes of collecting electronic data. Sitzmann, Ely, Brown and Bauer (2010) explain that self-report measures provide an efficient speedy means for assessing self-knowledge, but may possibly have limitations. In assessing human traits, such as self-perceptions of knowledge, results are likely to always contain some degree of error, thereby impacting on the validity and reliability of the questionnaire. The questionnaire was used to gauge educators' perceptions which were paramount in measuring LMS-TPACK, i.e. self-knowledge or estimates of what educators know, understand and are able to do can be inferred from self-report measures.

4.7 SCALE DEVELOPMENT (INSTRUMENT DESIGN)

The main objective of the current research was to develop and test the validity and reliability of the scale for defining future predictability of the new LMS-TPACK assessment instrument. The web-based self-report questionnaire can offer policy makers and professional development support staff a powerful method of assessing ODL educators' knowledge and readiness for effective LMS-based instruction. Consequently, to develop an empirical LMS-TPACK-based instrument and address the issue of validity and reliability, the researcher employed the scale development or test construction guidelines as prescribed by Clark and Watson (1995) and DeVellis (2003; 2012). In this section, the researcher reports the sequence of steps followed in the scale development of LMS-TPACK used to maximise validity and reliability. The steps are presented in Table 1.

Table 1: *Sequence of steps adapted and used in scale development of LMS-TPACK questionnaire (Clark & Watson, 1995; DeVellis, 2012)*

Research Objective	Steps	Actions Undertaken
Maximise content and face validity	Step 1	Conceptualisation: Using theory to clarify constructs
	Step 2	Literature review
	Step 3	Generating a preliminary item pool, i.e. operationalising constructs (construction of items/statements by adapting pre-published scales and creating new ones)
	Step 4	Determining the response format of the scale
	Step 5	Focus group
	Step 6	Pre-testing the questionnaire
	Step 7	Expert review and revisions

4.7.1 Step 1: Conceptualisation: Using theory to clarify constructs

According to DeVellis (2003), crystallising one's conceptual model represents a critical first step in scale development. This involves having a clear idea of what it is the researcher wants to measure and "being well grounded in the substantive theories related to the phenomenon to be measured" (p. 60). Clark and Watson (1995) warn that before any scale can be developed to assess constructs, the target construct(s) and theoretical context need to be established. For this reason, Mishra and Koehler's TPACK theory and related constructs were examined, i.e. technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK) and technological pedagogical content knowledge (TPACK). A subsequent step involved examining and understanding the ways in which TPACK as a cognitive property can be measured.

4.7.2 Step 2: Literature review

A comprehensive, but not exhaustive, literature review, as presented in Chapter 2, was necessary for the development of the questionnaire. The review, as advised by Clark and Watson (1995) and DeVellis (2003), included earlier TPACK research efforts focused on how others have conceptualised the constructs and described instrument development and assessment and validation methods. Moreover, analysis of the literature provided a next step in reinforcing content validity. It guided the scope of the content domain and simplified the context for LMS-TPACK (as described earlier on in the conceptual framework in Chapter 2). It also offered meaningful ideas for operationalising the constructs and generating relevant items for a preliminary item pool as listed in Table 2.

Table 2: *LMS-TPACK constructs and conceptual versus operational definitions*

LMS -TPACK Constructs	**Conceptual Definition** (As defined in Chapter 2)	**Forms of Knowledge** (Anderson, 2005; and Krathwohl, 2002) **Factual, conceptual and procedural knowledge**	**Operational Definition**
Learning management system knowledge	Generally encompasses knowledge about the LMS,	I know how to…	• modify/personalise the default Homepage

(LMS-K)	i.e. knowing how to manipulate and apply a variety of LMS-based tools and the ability to troubleshoot technical problems as they arise.		• upload Official Study Material • upload Prescribed Book Lists • publish discussions using the Discussion Forums tool • post information using the Announcements tool • customise the Schedule tool • upload Additional Resources • track assignments using the Assignments tool • export statistical reports using the Statistics tool • update module site settings using the Site Info tool
Pedagogical knowledge (PK)	Refers to a wide range of strategies, practices and methods of teaching that facilitate student distance learning as it applies generally across different subject domains.	I know how to…	• design study material for distance learning • align learning outcomes, instruction and assessment • draw from a range of learning theories • integrate a mix of student support strategies • use different assessment strategies • facilitate varied forms of interactions • sequence learning activities • link instructional activities to authentic experiences
Content knowledge (CK)	Includes knowledge of the curriculum, facts, concepts, theories, techniques and central topics and ability to select content for teaching that meets the requirements and standards of accredited professional bodies and broader educational goals.	I have knowledge of…	• the curriculum content in my discipline • key facts in my discipline • basic concepts in my discipline • fundamental theories that underpin my discipline • various techniques/procedures in my discipline • what constitutes legitimate knowledge in my discipline • how to package content for teaching that meets requirements of accredited professional bodies/educational standards in my discipline • central topics taught in my discipline
Pedagogical content knowledge (PCK)	Emphasises the blending of pedagogical and content knowledge. PCK includes knowledge of the students and their characteristics, the likely preconceptions and misconceptions students bring to the learning situation and an understanding of the full range of materials for instruction or tools of the trade, e.g. different texts, visual and audio tools.	Without using myUNISA tools, I know how to…	• address misconceptions students might have about the content • select instructional strategies that fit the content • pace learning so students are able to master the content • address concepts/topics students are likely to find easy or difficult • design interactive content for students to input or respond to • link students prior knowledge to the content • represent the content in multiple ways • make connections between various concepts/topics/related modules
Learning management system pedagogical knowledge (LMS-PK)	Refers to knowledge (content-free) about the tools and functions of the LMS and understanding how they might be used for instructional purposes.	I know how to use myUNISA to…	• orientate students online • scaffold learning online • create assessments online • design feedback online • make varied forms of representation online • monitor student learning online • provide for diverse digital

			capabilities of students online • form part of a blended mode
Learning management system content knowledge (LMS-CK)	Describes the knowledge associated with being a subject specialist (free of pedagogical strategies) and understanding how the LMS can be used to teach and bolster the content and how the nature of the content can be transformed.	I know how to use myUNISA to…	• direct students to web-based content • integrate third party software/tools to communicate concepts • demonstrate unobservable, obscure concepts invisible to the eye • transform the content • offer flexible access across multiple representations • chunk the content • generate online discussions that highlight key content • afford students opportunities to actively engage with the content
Learning management system technological pedagogical content knowledge (LMS-TPACK)	The manner in which knowledge about LMS tools, their pedagogical affordances, pedagogy, content, students and the ODL context are synthesised into an understanding of how to represent and formulate particular concepts. This entails knowing how to use the LMS to provide multiple alternative forms of representation, making it more accessible to students, having knowledge of instructional strategies (i.e. scaffolding, chunking, pacing, etc.) and using the LMS in any one or combination of ways to teach content, having knowledge of difficult or easy concepts and using the LMS to provide remedial actions and support students who encounter learning difficulties, knowing students' prior knowledge and experiences and using the LMS to link to existing knowledge, context and the new knowledge to be learnt, making the associations explicit.	I know how to…	• combine teaching strategies with myUNISA tools to transform the content • clarify difficult concepts by selecting myUNISA tools that afford varied forms of representation • integrate myUNISA tools with web-based content to support blended learning • create multiple online assessments using myUNISA tools that allow students to master the content • guide students to web-based content by making use of myUNISA tools that provide opportunities for flexible learning integrate myUNISA tools that allow students' to participate in online discussions related to content • use a team approach to integrate pedagogy, content and myUNISA tool use in the design of the module • combine content and myUNISA tools to provide students opportunities to interactively engage as part of their learning

4.7.3 Step 3: Generating a preliminary item pool

Once the content and context of the scale had been identified, the actual task of writing a preliminary item pool began. Pre-published scales were randomly selected from the literature and one or two items were adapted to match the scale development objective and to correspond to the theoretical conceptualisation of the latent LMS-TPACK constructs. Thereafter, to account for redundancy, multiple new items were created and classified to provide for an over-inclusive sample of items within each of the unique

LMS-TPACK constructs. DeVellis (2003) proposes that "by using multiple and seemingly redundant items, the content that is common to the items will summate across items while their irrelevant idiosyncrasies will cancel out" (p. 65). Similarly, Clark and Watson (1995) suggest that failure to represent a large enough sample of items in the initial pool "may mean that one or more of the constructs will be underrepresented in the final scale" (p. 311). Thus, to ensure that individual constructs were well represented in the initial item pool, a balanced number of eight to ten items were assigned to each unique TPACK construct. LMS-TPACK items were written as a declarative statement to elicit more complete responses (DeVellis, 2003) that tested for evidence of various forms or categories of knowledge, i.e. factual, conceptual and procedural knowledge (Anderson, 2005; Krathwohl, 2002).

The categories of knowledge denoted in Tables 2 and 3 are used to distinguish between different mental (thinking) processes or actions involved in teaching. These categories are ordered from simple to more complex cognitive operations as in the mind of educators. The categories also represent a cumulative hierarchy, in other words, it is assumed that mastery of the simpler category, e.g. factual knowledge, is prerequisite for mastery of the subsequent, more complex knowledge category, i.e. conceptual knowledge.

Table 3: *Structure of the knowledge dimension (adapted from Anderson, 2005; and Krathwohl, 2002)*

Factual Knowledge	**Conceptual Knowledge**	**Procedural Knowledge**
Knowledge of basic elements that educators **must have and know** to be acquainted with a particular subject matter or discipline <u>Knowledge of</u> • terminology • specific details and elements	**Knowing the interrelationships** between the basic elements within a larger structure that enable the elements to function together <u>Knowledge of</u> • categories and classifications • principles and generalisations • theories, models and structures	Knowing **how** to make or do something, including knowing **when** to use or **apply** knowledge <u>Knowledge of</u> • skills and algorithms • techniques and methods • criteria for deciding when to apply appropriate procedures

Simple → Complex

4.7.4 Step 4: Determining the response format of the scale

While creating the item pool, several response formats were investigated. The Likert scale was chosen for its flexibility and ease (McMillan & Schumacher, 2010) and common use in measuring TPACK (Koehler, Shin, & Mishra, 2012). Multiple response options which are widely used in human mental testing or ability testing (DeVellis, 2003) were applied in the five-point scale assigned to each statement, i.e. 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, 5 = Strongly agree and 6 = Not applicable. The middle values (Neither agree nor disagree) as proposed by Clark and Watson (1995) were included to ensure that subjects responded and did not make an incorrect choice. It was also important to permit subjects to select 'not applicable', particularly for those statements that may have contained content that respondents were not familiar with (McMillan & Schumacher, 2010). Subjects were asked to respond to each item by indicating to what extent they agreed or disagreed with each statement. For example, one item on the LMS knowledge subscale states: "I know how to modify/personalize the default Homepage". Respondents were asked to choose one response option from the specified scale that best aligned with their viewpoint.

4.7.5 Step 5: Focus group

Up to this point, the theory and literature review were used to generate a preliminary item pool to reflect the LMS-TPACK content. To further elucidate the content, the focus group method was employed. For Kontio et al. (2004), the focus group method is useful in studying theories and constructs as it provides an effective, inexpensive means for obtaining valuable insights and shared understandings from practitioners, whose feedback can be used to operationalise or clarify constructs. In this instance, six seasoned experts competent in ODL and LMS were invited to participate voluntarily in a focus group discussion (Appendix E). To ensure familiarity with and clarity about the content, subjects were given a TPACK PowerPoint presentation (Appendix F) and pre-discussion items (Appendix G). The group discussion lasted 90 minutes in which subjects were asked to evaluate the pre-group questionnaire, brainstorm their thoughts about the appropriateness of the content and provide individual written feedback. Responses were documented and analysed and relevant inputs incorporated to develop a first draft LMS-TPACK survey. A set of demographic questions were added and administered as part of the expert review asking respondents about gender, age, population group, highest qualification, and so forth.

4.7.6 Step 6: Expert review and revisions

As soon as the first draft had been finalised, the next step in the scale development process involved asking a group of experts to review the improved items. As DeVellis (2003) explains, "having items reviewed by experts for relevance to the domain of interest, can help to maximize item appropriateness" (p. 50). Nine lecturers (considered subject matter experts) from three different universities and two UNISA ICT specialists were invited to examine each item and rate how relevant they believed each item was for measuring LMS-TPACK. The draft survey (Appendix H) containing working definitions and 66 items with a 3-point scale (1 = Not necessary, 2 = Useful, but not necessary, and 3 = Essential) was emailed to the review panel to rate each item. Experts were also asked to evaluate the overall instrument, provide comments and suggestions on unclear instructions, ambiguous language and irrelevant items and identify phenomena the researcher may have failed to include. The reviewers' feedback was analysed and repetitions and weak items that lacked clarity and conciseness were modified or culled (DeVellis, 2003). It was recommended that descriptions of the LMS-TPACK categories be removed so that subjects were not orientated towards particular constructs when answering the survey. Responses were used to modify the item pool and improve overall survey design before administering a second draft LMS-TPACK questionnaire for pre-testing.

4.7.7 Step 7: Pre-testing the questionnaire

This next step represented one of the most important stages in the development of a new LMS-TPACK survey. This involved pre-testing the second draft self-report questionnaire on a small sample (n = 20), thereby allowing the researcher the opportunity to evaluate how the sample would respond to the instrument, identify errors and improve upon study design before finalising the survey for data collection (Fink & Litwin, 1995). While the objective of the pre-test was to gauge face validity, "a judgement that the items appear to be relevant" (McMillan & Schumacher, 2010, p. 175), DeVellis (2003) cautions that it may not be enough to support claims of validity (p. 57). Thus, the draft survey was emailed to a convenient sample arbitrarily chosen from the population in which educators were asked to complete the questionnaire and to provide comments on whether the items were clearly worded, whether there was any difficulty understanding the items and whether the response formats were appropriate for measuring each item (Fink & Litwin, 1995; McMillan & Schumacher, 2010). Comments about overall usability were also gathered, i.e. about the design, layout and length of time it took to complete the survey questionnaire. Eight items were removed as suggested and the improved LMS-TPACK survey was administered to a representative sample for data collection. See new myUNISA LMS-TPACK self-rating survey instrument, Appendix I.

Table 4: *Item summary for LMS-TPACK survey*

Scale	**No. of Items**	**Item Codes**
Learning management system knowledge (LMS-K)	10	LMS-K1 – LMS-K10
Pedagogical knowledge (PK)	8	PK1 – PK8
Content knowledge (CK)	8	CK1 – CK8
Pedagogical content knowledge (PCK)	8	PCK1 – PCK8
LMS pedagogical knowledge (LMS-PK)	8	LMS-PK1 – LMS-PK8
LMS content knowledge (LMS-CK)	8	LMS-CK1 – LMS-CK8
LMS technological pedagogical content knowledge (LMS-TPACK)	8	LMS-TPACK1 –LMS-TPACK8
	58	

4.8 DATA COLLECTION

The new LMS-TPACK survey containing 58 items (refer to item summary in Table 4) was administered via the UNISA server using LimeSurvey. An initial invitation, containing a hyperlink to the survey, was emailed to a target population comprising all UNISA educators on the Pretoria and Florida campuses. The cross-sectional survey (Creswell, 2012) made it possible to collect data at one time during September/October

2014 about educators' current perceptions regarding their myUNISA integration knowledge.

Several open-source survey software packages are available for designing, gathering and analysing survey data. In this instance, LimeSurvey offered a relatively easy and convenient way for designing and hosting the online questionnaire as well as gathering and analysing the data. A major advantage was its compatibility with SPSS (Statistical Package for the Social Sciences). This made it possible for responses to be directly entered into and stored in the database and easily transferred and converted to numerical data for meaningful statistical analysis. Automated personalised feedback was provided on individual findings, giving subjects a general indication of the knowledge areas that might need to be developed. Even though feedback was provided, the report served as a mere reflection and was not used for research purposes. Initial responses were slow and so a reminder follow-up email was sent (see Appendix J).

The sum of at least 300 subjects was the target sample size, with the objective being "to eliminate subject variance as a significant problem" (DeVellis, 2003, p. 87). The final sample size was 332 (full responses). Since a large enough sample was obtained, statistical analysis was performed to confirm or refute validity and reliability for the new LMS-TPACK instrument.

4.9 DATA ANALYSIS

In an attempt to develop and validate a new reliable instrument for assessing ODL educators' LMS-TPACK, this study addressed two research questions:

a) What are the *constructs and underlying dimensions* that need to be measured to ascertain LMS-TPACK?
b) Will the measuring instrument developed be *valid and reliable* for measuring the seven TPACK constructs described by Mishra and Koehler?

Firstly, TPACK theory and the literature review were used to establish the initial constructs and help clarify the underlying dimensions that emerged from the LMS-TPACK survey. To further strengthen the instrument's content and face validity, a focus group, expert review and pre-test were used to verify whether the underlying dimensions described in the LMS-TPACK survey were indeed represented. If the latent dimensions were confirmed to be present in the instrument, the survey could possibly be used for the purposes of measuring ODL educators' perceived LMS-TPACK. Subjects' responses could be used to more accurately assess the strengths and weaknesses of existing professional staff development programmes and facilitate the alignment of training that can meet the needs and competences of individual educators as well as connect with the broader institutional operational requirements.

Secondly, since a standardised instrument was not being used, the self-report questionnaire was tested for evidence of validity and reliability. Different statistical techniques using SPSS Statistics 22 software were applied. EFA was used for testing the validity of all the constructs in the questionnaire. This method is employed to describe variability among observed variables in terms of a smaller number of unobserved variables called factors (constructs). In other words, by reducing the large number of items, the seven latent constructs underlying LMS-TPACK could be identified. Individual items of one construct had to load (or contribute) significantly onto that specific construct as in the questionnaire. Item analysis was performed for testing the reliability of each construct in the LMS-TPACK questionnaire. Cronbach's alpha coefficients were calculated for each of the constructs as well as overall instrument reliability. The goal here was to establish whether the item related to with the particular construct for which it was intended. Items that failed to show significant relationships with the intended construct were then removed so as to attain a higher reliability coefficient. The following guiding procedures for validity and reliability testing as recommended by Williams, Onsman and Brown (2010) and Field (2013) was applied. See Figure 10. Each of these tests and their roles and functions will be elaborated upon in the next chapter (Chapter 5).

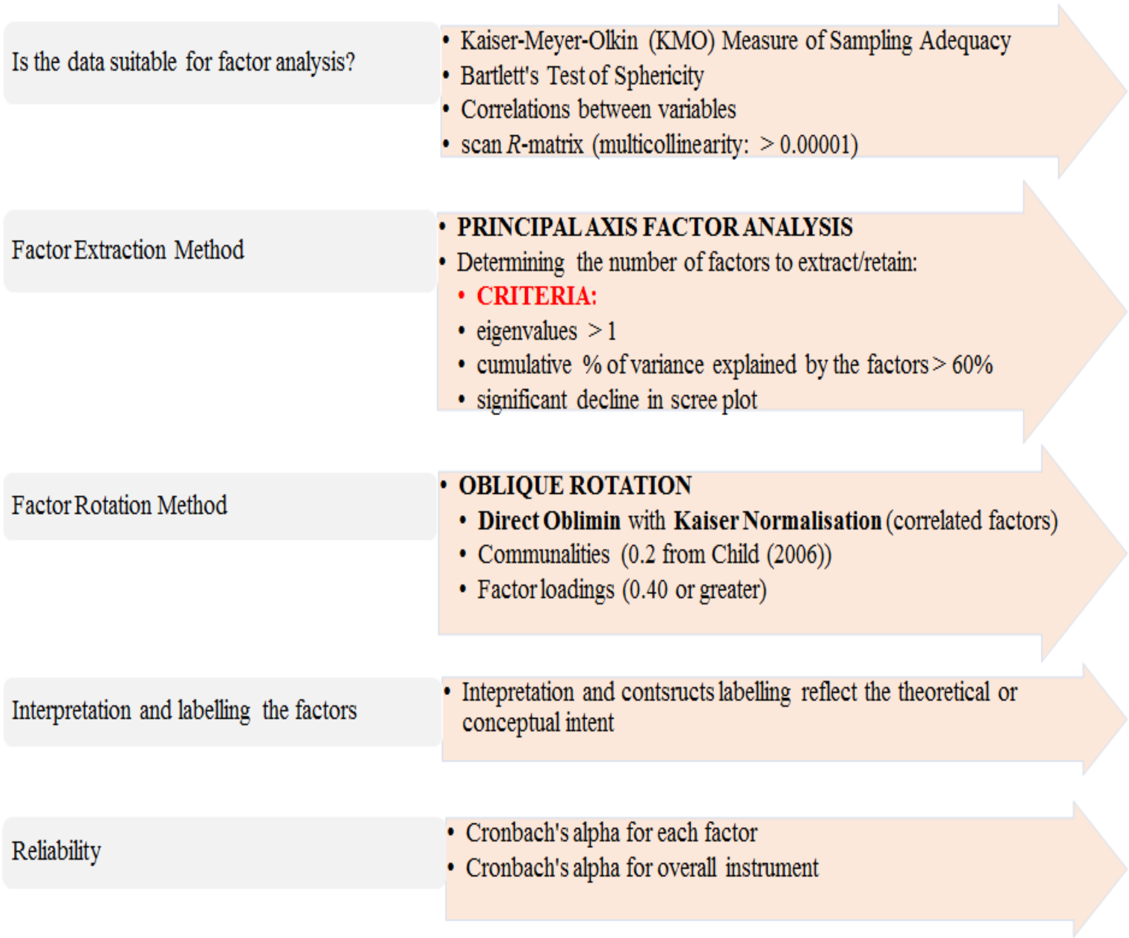

Figure 10: *Guiding procedures for validity and reliability testing (adapted from Williams et al., 2010, and Field, 2013)*

4.10 SUMMARY

The research approach and survey design were summarised in this chapter. The unit of analysis, the population, sample size and non-probability sampling method that were used to meet the research objectives, including the permissions needed for the study, were described. Since it was decided to make use of a web-based self-report questionnaire for quantitative data collection, the rationale for and scale development procedures to be followed in the construction of the test were presented. In conclusion, the data analysis and statistical techniques employed to test for instrument validity and reliability were described. Subsequently, the research results and findings will be described in Chapter 5.

CHAPTER FIVE

RESULTS AND FINDINGS

5.1 INTRODUCTION

This chapter presents the results and findings from the statistical analyses conducted during the development of the LMS-TPACK survey. Expert reviews were carried out prior to the survey pre-test. Descriptive statistics were used to describe the demographic variables and better understand the sample population. DeVellis (2003) sees factor analysis as an essential tool in scale development (p. 137). He states that a key function of factor analysis is to help the researcher determine the number of factors or constructs (latent variables) that underlie a set of items so that statistical techniques such as Cronbach's alpha can be computed correctly. Moreover, factor analysis is able to provide insight into the nature of the latent variables underlying the set of items. Both EFA (principal axis factoring) and reliability estimates of the LMS-TPACK survey were performed to establish a basis for instrument validity and reliability.

5.2 DATA ANALYSIS METHODOLOGY

This study followed the quantitative research approach for instrument development. Mishra and Koehler's TPACK theory and associated constructs (2006) were examined, including earlier TPACK research efforts on how others have conceptualised the constructs and described instrument development. Assessment and validation methods were reviewed and used for preliminary scale development. Following the construction of the LMS-TPACK instrument, a focus group, an expert review and a pre-test were conducted to begin building a case for validity. The LMS-TPACK scale was revised as suggested by the experts and later administered to a sample population. Three hundred and thirty-two questionnaires returned were analysed using SPSS Statistics 22 software for descriptive analysis, factor analysis and internal consistency reliability.

5.3 DESCRIPTIVE STATISTICS OF SUBJECTS

Descriptive analyses were performed using SPSS Statistics 22 software. The sample consisted of 332 in-service ODL educators. Two hundred and thirty of those educators had voluntarily completed myUNISA LMS training and 94 had not recently completed training. Descriptive statistics for the subjects' demographic data within UNISA are provided in Table 5.

Forty-seven educators were aged 20-29, 87 were aged 30-39, 81 were 40-49, 93 were 50-59 and 24 were 60 years of age or older. Over 60% of respondents (n = 202) were female and 39% were male (n = 130). Fifty-six per cent of the staff complement (n = 184) in UNISA identified themselves as belonging to the White population group and 34% (n = 112) as belonging to the Black (African), 6% to the Indian and 2% to the Coloured groups. Six educators indicated belonging to other population groups. Five per cent of educators (n = 17) had a first degree as their highest qualification, 21% (n = 71) had attained an Honours, 40% (n = 134) were in possession of a Master's and 33% (n = 110) had completed a PhD.

While nearly 40% of the educators (n = 129) reported that they had completed some sort of ICT-related qualification or course, over 60% (n = 203) had not attained a qualification or attended a course involving ICT. Educators were asked whether they had completed any endorsed teaching qualification or course. Fifty-eight per cent of the educators (n = 191) had completed an official teaching qualification or course, while 42% (n = 141) had not done any formal teaching qualification or course. Educators were required to indicate the number of years of distance teaching experience. Over 53% (n = 179) had 0 – 5 years' distance teaching experience, 13% had 6 – 10 years, 8% had 11 – 14 years, 8% had 15 – 20 years, 5% had 21 – 24 years, 9% had 25 – 30 years and 2% educators had 31+ years of distance teaching experience.

Respondents were asked to indicate their current frequency of use of particular technologies, applications and social media for teaching and supporting students. While a majority of the educators indicated frequent use of the myUNISA LMS on a daily and weekly basis, both on and off campus, a marginal number indicated use of Facebook, WhatsApp and Twitter and an even smaller number indicated use of podcasts and vodcasts. It appears that educators generally make very little use or in some cases no use of any form of social media for purposes of teaching and supporting students.

Table 5: *Demographic characteristics of LMS-TPACK respondents*

	n	Percentage (%)
Age		
20-29	47	14
30-39	87	26
40-49	81	24
50-59	93	28
60+	24	7
Gender		
Female	202	61
Male	130	39
Population group		
Black (African)	112	34
Indian	20	6
Coloured	7	2
White	184	56
Other	6	2
Highest qualification attained		
First degree	17	5
Honours	71	21
Master's	134	40
PhD	110	33
Completed any ICT-related qualification/course		
Yes	129	39
No	203	61
Completed any teaching qualification/course		
Yes	191	58
No	141	42
Attended myUNISA training		
Yes	238	72
No	94	28
Number of years' distance education teaching experience		
0 – 5 years	179	54
6 – 10 years	44	13
11 – 14 years	28	8
15 – 20 years	27	8
21 – 24 years	16	5
25 – 30 years	30	9
31+ years	8	2

Frequency of use of technologies/applications/social media currently used for teaching and supporting students

	Daily		Weekly		Monthly		Never	
	n	%	n	%	n	%	n	%
myUNISA on campus	193	58	98	30	28	8	13	4
myUNISA off campus	56	17	121	36	70	21	85	26
Videoconferencing	5	2	8	2	64	19	255	77
Mobile telephone	134	40	58	17	45	14	95	29
Facebook	41	12	33	10	22	7	236	71
WhatsApp	78	23	18	5	25	8	211	64
Twitter	20	6	13	4	17	5	282	85
Podcasts	6	2	17	5	57	17	252	76
Vodcasts	6	2	6	2	33	10	287	86

5.4 PRELIMINARY ANALYSIS

The initial form of output concerned data screening and sampling adequacy to ensure that the dataset was suitable for meaningful factor analysis. Univariate descriptive analyses were performed on educators' responses from the LMS-TPACK survey. Means and standard deviation scores for the 58 items were calculated for each variable. In this instance, principal axis factoring was used for the EFA, which does not depend on normality testing (skewness and kurtosis). Nonetheless, slight skewness was found for only two items, namely TK5 (2.37) and TK4 (2.03) but fell well within the range of 2 as recommended by West, Finch and Curran (1995). Descriptive statistics for all educators' responses for all LMS-TPACK items are presented in Table 6.

Table 6: *Descriptive statistics for educators' responses on the LMS-TPACK survey*

Item	*M*	*SD*
I know how to…		
LMS-K1 modify/personalise the default Homepage	4.04	1.217
LMS-K2 upload Official Study Material (e.g. Tutorial Letters, Study Guides, previous exam papers)	4.23	1.171
LMS-K3 upload Prescribed Book Lists (e.g. display prescribed books, recommended readings, e-reserves)	4.10	1.179
LMS-K4 publish discussions using the Discussion Forums tool (e.g. add module discussion activities, create topics to discuss assignment/exam queries)	4.43	.918
LMS-K5 post information using the Announcements tool (e.g. post messages on module site that can also be mailed to the class)	4.52	.850
LMS-K6 customize the Schedule tool (e.g. for posting and viewing deadlines, events related to a course)	3.62	1.261
LMS-K7 upload Additional Resources (e.g. class notes, multimedia files)	4.30	1.010
LMS-K8 track assignments using the Assignments tool (e.g. assignment statistics, MCQ marking reports, assignment status reports, marking statistics)	3.88	1.209
LMS-K9 export statistical reports using the Statistics tool (e.g. user visits, tool and resource activity)	3.34	1.380
LMS-K10 update module site settings using the Site Info tool	3.48	1.382
I know how to…		
PK1 design study material for distance learning	4.11	.865
PK2 align learning outcomes, instruction and assessment	4.20	.797
PK3 draw from a range of learning theories (e.g. behaviourism, constructivism, cognitivism, etc.)	3.63	1.062
PK4 integrate a mix of student support strategies (e.g. courseware, tutorials, feedback, practical work, sms, email)	4.12	.822
PK5 use different assessment strategies (e.g. formative, summative assessments)	4.37	.729
PK6 facilitate varied forms of interactions (e.g. between student-and-student, student-and-lecturer, student-and-tutor, student-and-content)	4.02	.874
PK7 sequence learning activities (e.g. from simple to complex)	4.09	.867
PK8 link instructional activities to authentic experiences (e.g. everyday real-life experiences)	4.16	.842
I have knowledge of…		
CK1 the curriculum content in my discipline (e.g. set of courses/modules that make up a full programme)	4.53	.640

CK2 key facts in my discipline	4.63	.580
CK3 basic concepts in my discipline (e.g. language, terminology, labels)	4.67	.507
CK4 fundamental theories that underpin my discipline (e.g. philosophies, rules, models, principles)	4.56	.572
CK5 various techniques/procedures in my discipline (e.g. methods, ways of doing things)	4.54	.561
CK6 what constitutes legitimate knowledge in my discipline (e.g. distinguish between correct and incorrect knowledge; fact and opinion)	4.55	.586
CK7 how to select content for teaching that meet requirements of accredited professional/ educational standards/bodies in my discipline	4.48	.663
CK8 central topics taught in my discipline	4.60	.534
Without using myUNISA, I know how to…		
PCK1 address misconceptions students might have about the content (e.g. misunderstandings, mistaken beliefs)	4.11	.871
PCK2 select instructional strategies that fit the content (e.g. group work, activity-based learning, experiential learning)	3.92	.995
PCK3 pace learning so students are able to master the content (e.g. timed readings, timed assessments)	3.97	.947
PCK4 address topics/concepts students are likely to find easy or difficult about the content	4.12	.913
PCK5 design interactive content for students to input or respond to (e.g. students input or respond to self-assessments, quizzes to generate a result)	3.80	1.068
PCK6 link students prior knowledge to the content (e.g. use introductory entry learning level activities, set baseline assessments)	3.94	.917
PCK7 represent the content in multiple ways (e.g. useful analogies, illustrations, examples, explanations)	4.07	.908
PCK8 make connections between various concepts/topics/related modules	4.11	.873
I know how to use myUNISA to…		
LMS-PK1 to orientate students online (e.g. clarify outcomes, instruction and assessment criteria in module site)	4.01	.894
LMS-PK2 scaffold learning online (e.g. guide students' learning from simple to more complex concepts/tasks)	3.84	.953
LMS-PK3 create assessments online (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	3.67	1.129
LMS-PK4 design multiple forms of feedback online (e.g. electronic, sms, Announcements, emails, comments in the grade book)	3.90	1.073
LMS-PK5 varied forms of representation online (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	3.55	1.122
LMS-PK6 monitor student learning online (e.g. assignment submissions and marks, discussions, blogs)	3.83	1.062
LMS-PK7 provide for diverse digital capabilities of students online (e.g. module site interface functional for novice users, disabled users, sensitive to language)	3.20	1.147
LMS-PK8 form part of a blended mode (e.g. combine print, online, face to face, other media)	3.79	1.051
I know how to use myUNISA to…		
LMS-CK1 direct students to web-based content (e.g. access through RSS feeds to online publishers, libraries)	3.36	1.184
LMS-CK2 integrate third party software/tools to communicate concepts (e.g. AutoCAD, GIS, DrGeo, Math Blaster, KGeography, Bookkeeper)	2.53	1.090
LMS-CK3 demonstrate unobservable, obscure facts/concepts/principles invisible to the eye (e.g. using illustrations, simulations, games, mind mapping)	2.96	1.159
LMS-CK4 transform the content (e.g. running an online video or simulation is different from reading printed text)	3.01	1.182
LMS-CK5 offer flexible access across multiple representations (e.g. link text, graphs, diagrams, videos, formulas)	3.04	1.212
LMS-CK6 chunk the content (e.g. split or break content into several smaller segments)	3.30	1.245
LMS-CK7 generate online discussions that highlight key content (e.g. draw attention to central topics/patterns/relationships using the Discussion forums tool)	3.83	1.066
LMS-CK8 afford students opportunities to actively engage with the content (e.g. foster student-centred learning)	3.71	1.059
I know how to…		
LMS-TPACK1 combine teaching strategies with myUNISA tools to transform the content (e.g. problem-based learning, experiential learning, activity-based learning)	3.58	1.008
LMS-TPACK2 clarify difficult concepts using/by selecting myUNISA tools that afford	3.34	1.109

different forms of representation (e.g. multimedia, visual, auditory illustrations, presentations, simulations)		
LMS-TPACK3 integrate myUNISA tools and web-based content to support blended learning (e.g. a combine print, other media)	3.49	1.113
LMS-TPACK4 create multiple assessments online using myUNISA tools that allow students to master the content (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	3.44	1.141
LMS-TPACK5 guide students to web-based content by making use of myUNISA tools that provide opportunities for flexible learning (e.g. students can learn and access materials at own time, place and space)	3.62	1.070
LMS-TPACK6 integrate myUNISA tools that allow students' to participate in online discussions related to content (e.g. discussion forums, blogs, wikis)	3.71	1.070
LMS-TPACK7 use a team approach to integrate pedagogy, content and myUNISA tools in the design of the module (e.g. complete certificate of due diligence)	3.45	1.221
LMS-TPACK8 combine content and myUNISA tools to provide students opportunities to interactively engage as part of their learning (e.g. students input/respond to online activities, assessments, discussions)	3.69	1.087

5.4.1 Sample size

Sample size is important in factor analysis. A factor pattern arising from a large factor analysis tends to be more stable than that resulting from a smaller sample. DeVellis (2012) explains that "the larger the number of items to be factored and the larger number of factors anticipated the more subjects should be included in the analysis" (p. 137). In this way, generalisability of inferences derived from factor analysis is increased from larger samples. However, since purposeful sampling was adopted for this study, results may not be generalised beyond the relevant population. Comrey and Lee (1992) classify 300 subjects as a good sample size needed to test for validity. In this study, the sample size of 332 subjects was obtained and deemed large enough to perform meaningful factor analysis.

5.4.2 Communality

The initial and extracted communality estimates were examined and are displayed in Table 7. Communality refers to the amount of common variance of a test, i.e. the variance that is shared in common with all other items. Higher communality is better. MacCallum, Widaman, Zhang and Hong (1999) suggest that as communalities become lower, the significance of the sample size increases. Child (2006) questions the significance of a variable in a factor analysis if communality of that variable is too low. He suggests that very low communalities (> 0.2) should be eliminated and the EFA rerun. In this instance, even though communalities were low for some items such as PK3 (0.37), they still loaded meaningfully on a factor and so they were not removed.

Table 7: *Communality estimates of the LMS-TPACK constructs (SPSS output)*

Item	Initial	Extraction
I know how to…		
LMS-K1 modify/personalise the default Homepage	.596	.508
LMS-K2 upload Official Study Material (e.g. Tutorial Letters, Study Guides, previous exam papers)	.552	.421
LMS-K3 upload Prescribed Book Lists (e.g. display prescribed books, recommended readings, e-reserves)	.531	.408
LMS-K4 publish discussions using the Discussion Forums tool (e.g. add module discussion activities, create topics to discuss assignment/exam queries)	.747	.695
LMS-K5 post information using the Announcements tool (e.g. post messages on module site that can also be mailed to the class)	.739	.648
LMS-K6 customize the Schedule tool (e.g. for posting and viewing deadlines, events related to a course)	.569	.467
LMS-K7 upload Additional Resources (e.g. class notes, multimedia files)	.747	.723
LMS-K8 track assignments using the Assignments tool (e.g. assignment statistics, MCQ marking reports, assignment status reports, marking statistics)	.690	.606
LMS-K9 export statistical reports using the Statistics tool (e.g. user visits, tool and resource activity)	.670	.592
LMS-K10 update module site settings using the Site Info tool	.653	.518
I know how to…		
PK1 design study material for distance learning	.656	.476
PK2 align learning outcomes, instruction and assessment	.698	.636
PK3 draw from a range of learning theories (e.g. behaviourism, constructivism, cognitivism, etc.)	.506	.373
PK4 integrate a mix of student support strategies (e.g. courseware, tutorials, feedback, practical work, sms, email)	.706	.629
PK5 use different assessment strategies (e.g. formative, summative assessments)	.689	.652
PK6 facilitate varied forms of interactions (e.g. between student-and-student, student-and-lecturer, student-and-tutor, student-and-content)	.599	.433
PK7 sequence learning activities (e.g. from simple to complex)	.645	.598
PK8 link instructional activities to authentic experiences (e.g. everyday real-life experiences)	.579	.464
I have knowledge of…		
CK1 the curriculum content in my discipline (e.g. set of courses/modules that make up a full programme)	.569	.427
CK2 key facts in my discipline	.727	.656
CK3 basic concepts in my discipline (e.g. language, terminology, labels)	.725	.669
CK4 fundamental theories that underpin my discipline (e.g. philosophies, rules, models, principles)	.728	.698
CK5 various techniques/procedures in my discipline (e.g. methods, ways of doing things)	.778	.733
CK6 what constitutes legitimate knowledge in my discipline (e.g. distinguish between correct and incorrect knowledge; fact and opinion)	.778	.739
CK7 how to select content for teaching that meet requirements of accredited professional/ educational standards/bodies in my discipline	.734	.628
CK8 central topics taught in my discipline	.713	.669
Without using myUNISA tools, I know how to…		
PCK1 address misconceptions students might have about the content (e.g. misunderstandings, mistaken beliefs)	.610	.490
PCK2 select instructional strategies that fit the content (e.g. group work, activity-based learning, experiential learning)	.724	.602
PCK3 pace learning so students are able to master the content (e.g. timed readings, timed assessments)	.722	.657
PCK4 address topics/concepts students are likely to find easy or difficult about the content	.789	.799

PCK5 design interactive content for students to input or respond to (e.g. students input or respond to self-assessments, quizzes to generate a result)	.648	.589
PCK6 link students prior knowledge to the content (e.g. use introductory entry learning level activities, set baseline assessments)	.787	.746
PCK7 represent the content in multiple ways (e.g. useful analogies, illustrations, examples, explanations)	.787	.692
PCK8 make connections between various concepts/topics/related modules	.821	.774
I know how to use myUNISA to…		
LMS-PK1 to orientate students online (e.g. clarify outcomes, instruction and assessment criteria in module site)	.709	.557
LMS-PK2 scaffold learning online (e.g. guide students' learning from simple to more complex concepts/tasks)	.712	.558
LMS-PK3 create assessments online (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	.728	.651
LMS-PK4 design multiple forms of feedback online (e.g. electronic, sms, Announcements, emails, comments in the grade book)	.658	.556
LMS-PK5 varied forms of representation online (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	.756	.670
LMS-PK6 monitor student learning online (e.g. assignment submissions and marks, discussions, blogs)	.651	.580
LMS-PK7 provide for diverse digital capabilities of students online (e.g. module site interface functional for novice users, disabled users, sensitive to language)	.738	.727
LMS-PK8 form part of a blended mode (e.g. combine print, online, face to face, other media)	.710	.567
I know how to use myUNISA to…		
LMS-CK1 direct students to web-based content (e.g. access through RSS feeds to online publishers, libraries)	.714	.630
LMS-CK2 integrate third party software/tools to communicate concepts (e.g. AutoCAD, GIS, DrGeo, Math Blaster, KGeography, Bookkeeper)	.637	.545
LMS-CK3 demonstrate unobservable, obscure facts/concepts/principles invisible to the eye (e.g. using illustrations, simulations, games, mind mapping)	.744	.678
LMS-CK4 transform the content (e.g. running an online video or simulation is different from reading printed text)	.816	.772
LMS-CK5 offer flexible access across multiple representations (e.g. link text, graphs, diagrams, videos, formulas)	.836	.809
LMS-CK6 chunk the content (e.g. split or break content into several smaller segments)	.728	.631
LMS-CK7 generate online discussions that highlight key content (e.g. draw attention to central topics/patterns/relationships using the Discussion forums tool)	.689	.586
LMS-CK8 afford students opportunities to actively engage with the content (e.g. foster student-centred learning)	.687	.554
I know how to…		
LMS-TPACK1 combine teaching strategies with myUNISA tools to transform the content (e.g. problem-based learning, experiential learning, activity-based learning)	.775	.699
LMS-TPACK2 clarify difficult concepts using/by selecting myUNISA tools that afford different forms of representation (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	.803	.692
LMS-TPACK3 integrate myUNISA tools and web-based content to support blended learning (e.g. a combine print, other media)	.773	.651
LMS-TPACK4 create multiple assessments online using myUNISA tools that allow students to master the content (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	.782	.673
LMS-TPACK5 guide students to web-based content by making use of myUNISA tools that provide opportunities for flexible learning (e.g. students can learn and access materials at own time, place and space)	.803	.682
LMS-TPACK6 integrate myUNISA tools that allow students' to participate in online discussions related to content (e.g. discussion forums, blogs, wikis)	.722	.662
LMS-TPACK7 use a team approach to integrate pedagogy, content and myUNISA tools in the design of the module (e.g. complete certificate of due diligence)	.702	.557
LMS-TPACK8 combine content and myUNISA tools to provide students opportunities to interactively engage as part of their learning (e.g. students input/respond to online activities, assessments, discussions)	.764	.649

Extraction method: Principal axis factoring

5.4.3 Correlation matrix

Multicollinearity or singularity was examined by producing and scanning the correlation matrix or R-matrix for variables that correlated well, which meant looking for correlations "greater than .3 [and] greater than .9" (Field, 2013, p. 694). Patterned relationships among variables did not indicate any problem. As a follow-up, the determinant score was confirmed. For these data its value was 5.630E-23 (determinant = 0.0005630), which is greater than the required value of 0.0001 (Field, 2009).

5.4.4 Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy

Various tests were done prior to the factor extraction, i.e. KMO and Bartlett's test of Sphericity, to gauge the appropriateness of the respondents' data for meaningful factor analysis. Table 8 presents the results of the tests. The KMO denotes the ratio of the squared relationships (correlations) among variables to the squared partial relationship between variables. A value close to 1 suggests that patterns of relationships are relatively compact; thus factor analysis ought to yield distinct reliable factors (Field, 2013). For the KMO statistic the value was .936, which is well above .50, the minimum criteria that Kaiser and Rice (1974) recommend, and falls into the category of 'marvellous'.

Table 8: *KMO measure of sampling adequacy and Bartlett's test of Sphericity*

KMO measure of sampling adequacy		.936
Bartlett's test of Sphericity	Approx. Chi-Square	13055.453
	df	1653
	Sig.	.000

5.4.5 Bartlett's test of Sphericity

Bartlett's test of Sphericity inspects whether the variance-covariance matrix is proportionate to the identity matrix (Field, 2013). This was found to be significant (*Sig.* < .000); the p-value of the Bartlett's test was less than 0.5 (Bartlett's X^2 = 13055.453, df – 1653, p < .000). The researcher was thus confident that the resulting correlation structure between the individual variables was strong enough to conduct a viable factor analysis that would produce clear-cut reliable factors.

5.5 VALIDITY

5.5.1 Factor extraction

Principal axis factor analysis was applied to educators' responses to ascertain whether the 58 items would load onto the seven constructs as anticipated in the LMS-TPACK questionnaire, i.e. TK, PK, CK, PCK, LMS-PK, LMS-CK and LMS-TPACK. In this way, the large number of items in the questionnaire could be reduced to a smaller number of factors (or constructs), thereby providing validity evidence of the self-reporting scale. Williams et al. (2010) recommend that among the many critical decisions for reducing factors is determining the appropriate number of factors to extract and rotate in the data set.

5.5.2 Determining the number of factors

Subsequently, multiple criteria were applied to assist in choosing the optimum number of factors to extract or retain. Field (2013) suggests that factor analysts ought to employ a variety of measures in order to avoid the under- or over-extraction of true underlying dimensions. This is in line with Thompson and Daniel (1996) who assert that the "simultaneous use of multiple decision rules is appropriate and often desirable" (p. 200). Accordingly, the following criteria were applied: (a) eigenvalues > 1, (b) cumulative percentage of variance extracted and (c) the significant decline in the scree plot.

CRITERION 1: Eigenvalues >1

The initial measure of the factor extraction process involved examining the size of eigenvalues of the correlation matrix (R-matrix). In this instance, the most commonly used criterion, known as the Kaiser Guttman rule, was applied. Kaiser (1956; 1960) recommends that all factors with eigenvalues greater than 1 be retained. The eigenvalues associated with every factor prior to extraction, after extraction and after rotation are displayed in Table 9. From Table 9 nine factors have eigenvalues greater than 1 and would have been considered. However, the theoretical and conceptual intent suggests that not more than seven factors should be counted. As a result, an alternative criterion of determining the correct number of factors to be retained was used, namely cumulative percentage of variance (Field, 2013).

CRITERION 2: Cumulative percentage of variance

The first section of Table 9 lists the initial eigenvalues or the amount of variance in the original variables accounted for by each factor. For the initial solution, there are as many factors as variables. Consequently, SPSS identified a total of 58 factors within the initial data set. The percentage of variance is also displayed. Relatively large amounts of variance are explained by two factors, i.e. factor 1 = 34.206% and factor 2 = 11.094%, whereas successive factors explain smaller amounts of variance.

The next section of Table 9 shows the extracted factors. By applying a seven-factor solution combined with the default SPSS Kaiser's criterion, six factors with eigenvalues greater than 1 were extracted. They explain 60% of the variability in the original 58 variables. According to Hair, Black, Babin and Anderson (2010), a 60% cumulative percentage of total variance extracted by successive factors is deemed satisfactory and significant for the derived factors. This measure suggests that the complexity of the items can be considerably reduced to six factors, with only a 2% loss of information. Subsequently, the rotation changed the individual totals (eigenvalues), producing more evenly spread values across the six factors and thus making it easier to interpret the relative importance of each factor.

Table 9: Total variance explained (SPSS output)

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	19.840	34.206	34.206	19.464	33.559	33.559	14.894
2	6.435	11.094	45.301	6.092	10.504	44.063	7.854
3	4.089	7.051	52.351	3.765	6.491	50.555	7.563
4	2.767	4.771	57.122	2.384	4.110	54.665	10.884
5	2.365	4.077	61.200	1.932	3.331	57.995	9.312
6	1.584	2.730	63.930	1.173	2.023	60.018	1.427
7	1.301	2.243	66.173	.940	1.621	61.640	12.144
8	1.063	1.832	68.005				
9	1.009	1.740	69.745				
10	.917	1.580	71.326				
11	.867	1.495	72.821				
12	.856	1.475	74.296				
13	.782	1.349	75.645				
14	.747	1.289	76.934				
15	.723	1.246	78.179				
16	.679	1.171	79.350				
17	.615	1.061	80.411				
18	.576	.993	81.403				
19	.571	.985	82.389				
20	.550	.948	83.336				
21	.542	.935	84.272				
22	.481	.830	85.101				
23	.452	.780	85.881				
24	.434	.748	86.629				
25	.422	.727	87.357				
26	.393	.678	88.035				
27	.379	.654	88.689				
28	.365	.630	89.319				
29	.357	.616	89.934				
30	.338	.582	90.517				
31	.333	.574	91.090				
32	.320	.551	91.642				
33	.309	.532	92.174				
34	.299	.516	92.690				
35	.279	.481	93.171				
36	.266	.458	93.629				
37	.256	.441	94.071				
38	.246	.424	94.495				
39	.235	.405	94.900				

40	.226	.389	95.289				
41	.219	.377	95.666				
42	.206	.355	96.021				
43	.198	.342	96.363				
44	.193	.333	96.696				
45	.183	.315	97.011				
46	.180	.310	97.320				
47	.167	.288	97.609				
48	.160	.277	97.885				
49	.158	.272	98.157				
50	.151	.259	98.417				
51	.139	.239	98.656				
52	.133	.230	98.886				
53	.125	.216	99.102				
54	.125	.215	99.317				
55	.108	.186	99.503				
56	.101	.175	99.678				
57	.096	.166	99.844				
58	.090	.156	100.000				

Extraction method: Principal axis factoring

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

CRITERION 3: Scree plot

While eigenvalues, cumulative percentages of variance and communalities are very useful criteria for factor extraction, a scree plot provides an added reliable method for retaining the optimal number of factors. Cattell (1966) in Field (2013) suggests that by plotting and inspecting each eigenvalue on a scree plot (or graph), the relative position of each factor will become evident. He recommends retaining the high eigenvalues along the steep slope (Y-axis) to the left of the point of inflexion (where the slope of the line changes drastically) and not to retain the factors on the shallow slope (X-axis).

In this instance, the scree plot was ambiguous and displayed inflexions that would justify retaining five or six factors. However, after careful consideration, six factors were retained for a variety of reasons: including a large enough sample size, the combination of the scree plot and Kaiser's rule and because it made theoretical and logical sense as indicators of clear TPACK constructs. Figure 11 supports the resulting six factors left of the point of inflexion that was retained. Six factors were later used for the rotation.

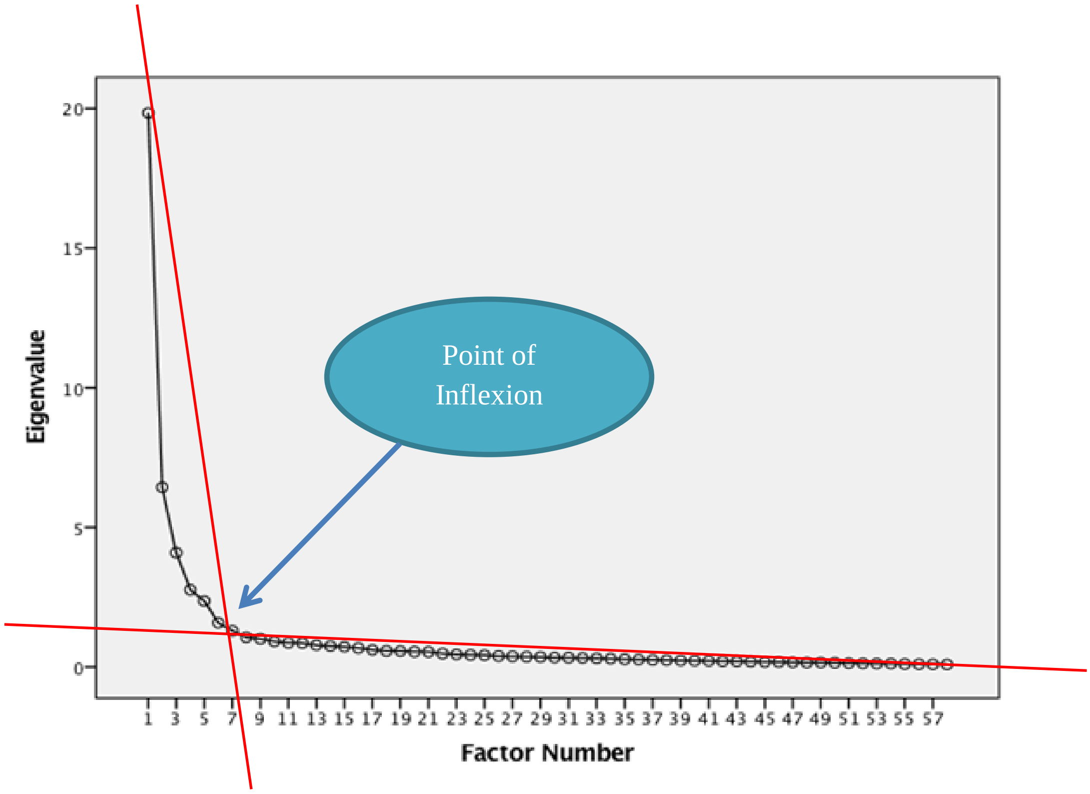

Figure 11: *Scree plot (SPSS output) indicating that the data have six factors*

5.5.3 Factor rotation

The objective of factor rotation is to optimise and simplify a more meaningful factor solution. Since it was assumed that the underlying factors were correlated to one another, the oblique rotation (direct oblimin with Kaiser normalisation) was chosen. Costello and Osborne (2005) state that correlations are generally expected among factors when studying human behaviour and performance. They recommend oblique rotational methods be used as this would theoretically extract a more accurate and possibly a more reproducible solution.

Seeing as the LMS-TPACK model specified seven factors and strongly suggested correlated constructs, the resulting factor solution showed items loading on distinct factors, suggesting six possible factors, i.e. LMS-K (factor 4), PK (factor 5), CK (factor

2), PCK (factor 3) and LMS-PK (factor 6), while LMS-CK and LMS-TPACK items loaded as a unique single factor (factor 1). Subsequently, a second and third factor analysis with six and five factors, respectively, was done. The factors were rotated using the oblique rotation method (direct oblimin with Kaiser normalisation), but since the statistical differences were not substantial, the six-factor solution was retained (Hair et al., 2010).

The rotated pattern matrix for the 58 items on the six-factor solution is presented in Table 10. An item was said to load on a given factor if the factor loading was .40 and greater for that factor and less than .40 for the other factor. In this instance, LMS-PK8 (< .40) did not load onto any factor above .40 and so it was removed. In contrast, even though LMS-CK7 (-.409) loaded

, it was also removed as it, too, did not load significantly onto any factor. LMS-TPACK4 had cross-loadings, in other words, the variable had two loadings that exceeded the threshold value (in this case .40 and greater) deemed necessary for inclusion in the factor interpretation. LMS-TPACK4 had loadings of .456 and .431 on factors 1 and 7, respectively. Consequently, the item was removed.

Table 10: *Pattern matrix*[a][3]

Item	Factor						
	1	2	3	4	5	6	7
I know how to…							
LMS-K1 modify/personalise the default Homepage				.662			
LMS-K2 upload Official Study Material (e.g. Tutorial Letters, Study Guides, previous exam papers)				.524			
LMS-K3 upload Prescribed Book Lists (e.g. display prescribed books, recommended readings, e-reserves)				.585			
LMS-K4 publish discussions using the Discussion Forums tool (e.g. add module discussion activities, create topics to discuss assignment/exam queries)				.725			
LMS-K5 post information using the Announcements tool (e.g. post messages on module site that can also be mailed to the class)				.787			
LMS-K6 customize the Schedule tool (e.g. for posting and viewing deadlines, events related to a course)				.482			
LMS-K7 upload Additional Resources (e.g.				.779			

[3] By default SPSS lists all factor loadings, but in order to increase meaningful interpretation of the rotated pattern matrix and structure matrix, factor loadings below.40 (cut-off) were not printed or reported in the results. Only LMS-PK8 (< .40) was reported in the pattern matrix.

class notes, multimedia files)							
LMS-K8 track assignments using the Assignments tool (e.g. assignment statistics, MCQ marking reports, assignment status reports, marking statistics)				.649			
LMS-K9 export statistical reports using the Statistics tool (e.g. user visits, tool and resource activity)				.488			
LMS-K10 update module site settings using the Site Info tool				.482			
I know how to…							
PK1 design study material for distance learning					-.601		
PK2 align learning outcomes, instruction and assessment					-.750		
PK3 draw from a range of learning theories (e.g. behaviourism, constructivism, cognitivism, etc.)					-.557		
PK4 integrate a mix of student support strategies (e.g. courseware, tutorials, feedback, practical work, sms, email)					-.671		
PK5 use different assessment strategies (e.g. formative, summative assessments)					-.682		
PK6 facilitate varied forms of interactions (e.g. between student-and-student, student-and-lecturer, student-and-tutor, student-and-content)					-.544		
PK7 sequence learning activities (e.g. from simple to complex)					-.678		
PK8 link instructional activities to authentic experiences (e.g. everyday real-life experiences)					-.666		
I have knowledge of…							
CK1 the curriculum content in my discipline (e.g. set of courses/modules that make up a full programme)		.615					
CK2 key facts in my discipline		.805					
CK3 basic concepts in my discipline (e.g. language, terminology, labels)		.798					
CK4 fundamental theories that underpin my discipline (e.g. philosophies, rules, models, principles)		.843					
CK5 various techniques/procedures in my discipline (e.g. methods, ways of doing things)		.854					
CK6 what constitutes legitimate knowledge in my discipline (e.g. distinguish between correct and incorrect knowledge; fact and opinion)		.873					
CK7 how to select content for teaching that meet requirements of accredited professional/ educational standards/bodies in my discipline		.714					
CK8 central topics taught in my discipline		.754					
Without using myUNISA tools, I know how to…							
PCK1 address misconceptions students might have about the content (e.g. misunderstandings, mistaken beliefs)			.631				
PCK2 select instructional strategies that fit the content (e.g. group work, activity-based learning, experiential learning)			.681				
PCK3 pace learning so students are able to master the content (e.g. timed readings, timed assessments)			.757				
PCK4 address topics/concepts students are likely to find easy or difficult about the content			.914				

PCK5 design interactive content for students to input or respond to (e.g. students input or respond to self-assessments, quizzes to generate a result)			.735				
PCK6 link students prior knowledge to the content (e.g. use introductory entry learning level activities, set baseline assessments)			.855				
PCK7 represent the content in multiple ways (e.g. useful analogies, illustrations, examples, explanations)			.843				
PCK8 make connections between various concepts/topics/related modules			.882				
I know how to use myUNISA to…							
LMS-PK1 to orientate students online (e.g. clarify outcomes, instruction and assessment criteria in module site)							.551
LMS-PK2 scaffold learning online (e.g. guide students' learning from simple to more complex concepts/tasks)							.514
LMS-PK3 create assessments online (e.g. closed/open ended questions, timed assessments, matching questions, question pools)							.667
LMS-PK4 design multiple forms of feedback online (e.g. electronic, sms, Announcements, emails, comments in the grade book)							.585
LMS-PK5 varied forms of representation online (e.g. multimedia, visual, auditory illustrations, presentations, simulations)							.490
LMS-PK6 monitor student learning online (e.g. assignment submissions and marks, discussions, blogs)							.628
LMS-PK7 provide for diverse digital capabilities of students online (e.g. module site interface functional for novice users, disabled users, sensitive to language)							.604
LMS-PK8 form part of a blended mode (e.g. combine print, online, face to face, other media)	.262	.033	.055	.158	-.095	-.013	.390
I know how to use myUNISA to…							
LMS-CK1 direct students to web-based content (e.g. access through RSS feeds to online publishers, libraries)	.708						
LMS-CK2 integrate third party software/tools to communicate concepts (e.g. AutoCAD, GIS, DrGeo, Math Blaster, KGeography, Bookkeeper)	.713						
LMS-CK3 demonstrate unobservable, obscure facts/concepts/principles invisible to the eye (e.g. using illustrations, simulations, games, mind mapping)	.833						
LMS-CK4 transform the content (e.g. running an online video or simulation is different from reading printed text)	.892						
LMS-CK5 offer flexible access across multiple representations (e.g. link text, graphs, diagrams, videos, formulas)	.890						
LMS-CK6 chunk the content (e.g. split or break content into several smaller segments)	.725						
LMS-CK7 generate online discussions that highlight key content (e.g. draw attention to central topics/patterns/relationships using the Discussion forums tool)						-.409	
LMS-CK8 afford students opportunities to actively engage with the content (e.g. foster	.515						

student-centred learning)							
I know how to…							
LMS-TPACK1 combine teaching strategies with myUNISA tools to transform the content (e.g. problem-based learning, experiential learning, activity-based learning)	.578						
LMS-TPACK2 clarify difficult concepts using/by selecting myUNISA tools that afford different forms of representation (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	.736						
LMS-TPACK3 integrate myUNISA tools and web-based content to support blended learning (e.g. a combine print, other media)	.676						
LMS-TPACK4 create multiple assessments online using myUNISA tools that allow students to master the content (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	.456						.431
LMS-TPACK5 guide students to web-based content by making use of myUNISA tools that provide opportunities for flexible learning (e.g. students can learn and access materials at own time, place and space)	.609						
LMS-TPACK6 integrate myUNISA tools that allow students' to participate in online discussions related to content (e.g. discussion forums, blogs, wikis)	.552						
LMS-TPACK7 use a team approach to integrate pedagogy, content and myUNISA tools in the design of the module (e.g. complete certificate of due diligence)	.537						
LMS-TPACK8 combine content and myUNISA tools to provide students opportunities to interactively engage as part of their learning (e.g. students input/respond to online activities, assessments, discussions)	.525						

Extraction method: Principal axis factoring

Rotation method: Oblimin with Kaiser normalisation[a]

a. Rotation converged in 18 iterations

To avoid misinterpretation of correlated factors the structure matrix (see Table 11) was also examined (Graham, Guthrie, & Thompson, 2003). It contrasts with the pattern matrix in that the common variance is not overlooked. With the exclusion of factors 2, 3 and 5, numerous items loaded highly on more than one factor. This came about as a result of the association between factors 1 and 4 and between factors 4 and 7. After analysis of the rotated pattern matrix and structure matrix, the factors were interpreted and the constructs labelled.

Table 11: *Structure matrix*

Items	Factors						
	1	2	3	4	5	6	7
I know how to…							
LMS-K1 modify/personalise the default Homepage				.690			
LMS-K2 upload Official Study Material (e.g. Tutorial Letters, Study Guides, previous exam papers)				.623			.438
LMS-K3 upload Prescribed Book Lists (e.g. display prescribed books, recommended readings, e-reserves)				.619			
LMS-K4 publish discussions using the Discussion Forums tool (e.g. add module discussion activities, create topics to discuss assignment/exam queries)				.772			
LMS-K5 post information using the Announcements tool (e.g. post messages on module site that can also be mailed to the class)				.781			
LMS-K6 customize the Schedule tool (e.g. for posting and viewing deadlines, events related to a course)	.461			.628			.482
LMS-K7 upload Additional Resources (e.g. class notes, multimedia files)	.415			.830			.435
LMS-K8 track assignments using the Assignments tool (e.g. assignment statistics, MCQ marking reports, assignment status reports, marking statistics)	.412			.737			.504
LMS-K9 export statistical reports using the Statistics tool (e.g. user visits, tool and resource activity)	.536			.657			.524
LMS-K10 update module site settings using the Site Info tool	.546			.646			.507
I know how to…							
PK1 design study material for distance learning					-.667		
PK2 align learning outcomes, instruction and assessment		.428			-.782		
PK3 draw from a range of learning theories (e.g. behaviourism, constructivism, cognitivism, etc.)					-.560		
PK4 integrate a mix of student support strategies (e.g. courseware, tutorials, feedback, practical work, sms, email)				.448	-.741		
PK5 use different assessment strategies (e.g. formative, summative assessments)		.440			-.765		
PK6 facilitate varied forms of interactions (e.g. between student-and-student, student-and-lecturer, student-and-tutor, student-and-content)					-.626		
PK7 sequence learning activities (e.g. from simple to complex)					-.748		
PK8 link instructional activities to authentic experiences (e.g. everyday real-life experiences)					-.670		
I have knowledge of…							
CK1 the curriculum content in my discipline (e.g. set of courses/modules that make up a full programme)		.634					
CK2 key facts in my discipline		.805					
CK3 basic concepts in my discipline (e.g. language, terminology, labels)		.809					
CK4 fundamental theories that underpin my discipline (e.g. philosophies, rules, models, principles)		.826					
CK5 various techniques/procedures in my		.855					

discipline (e.g. methods, ways of doing things)							
CK6 what constitutes legitimate knowledge in my discipline (e.g. distinguish between correct and incorrect knowledge; fact and opinion)		.858					
CK7 how to select content for teaching that meet requirements of accredited professional/ educational standards/bodies in my discipline		.777			-.410		
CK8 central topics taught in my discipline		.801					
Without using myUNISA tools, I know how to…							
PCK1 address misconceptions students might have about the content (e.g. misunderstandings, mistaken beliefs)			.676				
PCK2 select instructional strategies that fit the content (e.g. group work, activity-based learning, experiential learning)			.749				
PCK3 pace learning so students are able to master the content (e.g. timed readings, timed assessments)			.796				
PCK4 address topics/concepts students are likely to find easy or difficult about the content			.890				
PCK5 design interactive content for students to input or respond to (e.g. students input or respond to self-assessments, quizzes to generate a result)			.747				
PCK6 link students prior knowledge to the content (e.g. use introductory entry learning level activities, set baseline assessments)			.862				
PCK7 represent the content in multiple ways (e.g. useful analogies, illustrations, examples, explanations)			.825				
PCK8 make connections between various concepts/topics/related modules			.876				
I know how to use myUNISA to…							
LMS-PK1 to orientate students online (e.g. clarify outcomes, instruction and assessment criteria in module site)	.491			.500			.708
LMS-PK2 scaffold learning online (e.g. guide students' learning from simple to more complex concepts/tasks)	.560			.489			.708
LMS-PK3 create assessments online (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	.575			.467			.786
LMS-PK4 design multiple forms of feedback online (e.g. electronic, sms, Announcements, emails, comments in the grade book)	.463			.455			.704
LMS-PK5 varied forms of representation online (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	.683			.477	-.412		.745
LMS-PK6 monitor student learning online (e.g. assignment submissions and marks, discussions, blogs)	.505			.494			.735
LMS-PK7 provide for diverse digital capabilities of students online (e.g. module site interface functional for novice users, disabled users, sensitive to language)	.698			.428			.775
LMS-PK8 form part of a blended mode (e.g. combine print, online, face to face, other media)	.627			.520			.672
I know how to use myUNISA to…							
LMS-CK1 direct students to web-based content (e.g. access through RSS feeds to online publishers, libraries)	.781			.448			.511
LMS-CK2 integrate third party software/tools to communicate concepts (e.g. AutoCAD, GIS,	.708						

DrGeo, Math Blaster, KGeography, Bookkeeper)							
LMS-CK3 demonstrate unobservable, obscure facts/concepts/principles invisible to the eye (e.g. using illustrations, simulations, games, mind mapping)	.816			.400			.455
LMS-CK4 transform the content (e.g. running an online video or simulation is different from reading printed text)	.870			.404			.481
LMS-CK5 offer flexible access across multiple representations (e.g. link text, graphs, diagrams, videos, formulas)	.893			.408			.535
LMS-CK6 chunk the content (e.g. split or break content into several smaller segments)	.784			.401			.507
LMS-CK7 generate online discussions that highlight key content (e.g. draw attention to central topics/patterns/relationships using the Discussion forums tool)	.580			.432		-.447	.560
LMS-CK8 afford students opportunities to actively engage with the content (e.g. foster student-centred learning)	.672			.453			.555
I know how to…							
LMS-TPACK1 combine teaching strategies with myUNISA tools to transform the content (e.g. problem-based learning, experiential learning, activity-based learning)	.762			.417	-.413		.646
LMS-TPACK2 clarify difficult concepts using/by selecting myUNISA tools that afford different forms of representation (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	.818			.415			.589
LMS-TPACK3 integrate myUNISA tools and web-based content to support blended learning (e.g. a combine print, other media)	.787			.427			.578
LMS-TPACK4 create multiple assessments online using myUNISA tools that allow students to master the content (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	.735			.422			.730
LMS-TPACK5 guide students to web-based content by making use of myUNISA tools that provide opportunities for flexible learning (e.g. students can learn and access materials at own time, place and space)	.773			.438			.645
LMS-TPACK6 integrate myUNISA tools that allow students' to participate in online discussions related to content (e.g. discussion forums, blogs, wikis)	.710			.459			.592
LMS-TPACK7 use a team approach to integrate pedagogy, content and myUNISA tools in the design of the module (e.g. complete certificate of due diligence)	.713			.413			.567
LMS-TPACK8 combine content and myUNISA tools to provide students opportunities to interactively engage as part of their learning (e.g. students input/respond to online activities, assessments, discussions)	.719			.442			.639

Extraction method: Principal axis factoring

Rotation method: Oblimin with Kaiser normalisation

5.5.4 Interpretation and construct labelling

Interpretation involved examining which items were attributable to a particular factor (or construct) and giving that factor or construct a name or label. A minimum of two or three items needed to load onto a factor so that it was possible to assign a meaningful interpretation (Williams et al., 2010). The labelling of factors was further confirmed based on several unique high item loadings in the resultant pattern matrix. In other words, the coefficient of the substantive importance of items or variables to a factor was scrutinised. Special care was taken by the factor analyst to ensure against simply allowing statistical criteria to name or label a factor (Pedhazur & Schmelkin, 1991). Rather, the researcher considered the extent and intricacies of the factor as well as its association with the original conceptualisation. The labels or constructs needed to mirror the theoretical and conceptual intention. After assessing the loadings in both the pattern and structure matrix as presented in Tables 6 and 7, six factors were produced and the factors are interpreted as follows:

FACTOR 1

None of the LMS-CK items and LMS-TPACK items (.40 and greater) resulted in different factors or constructs loading. Instead, they loaded on a single factor. Clark and Watson (1995) do not think it wise to simply eliminate the items without considering why they did not show up as expected. Possible explanations for this occurrence could be that perhaps (1) subjects may have had difficulty distinguishing between the LMS-CK and LMS-TPACK items, (2) the writing of items did not sufficiently discriminate between the two constructs, (3) the two constructs are inherently the same or (4) the theory is inadequate. Perhaps LMS-CK (TCK) simply does not exist (Hofer & Harris, 2012; Lux, 2010; Robertson, 2008). After careful consideration of the statistical criteria and literature reviewed, factor 1 was named LMS-TPACK to reflect both the theoretical and conceptual objective.

FACTOR 2

Items CK1-CK8 had significant loadings (.40 and greater) clustering on factor 2. These items describe an ODL educator’s knowledge of the curriculum, facts, concepts, theories, techniques and central topics and the ability to select content for teaching that meets the requirements and standards of accredited professional bodies and broader educational goals. Thus factor 2 was named content knowledge (CK).

FACTOR 3

The items with highest loadings on factor 3 comprise PCK1 to PCK8. These items refer to the blending of pedagogical and content knowledge and depict an educator's knowledge of students and their characteristics, the likely preconceptions and misconceptions they might bring to the learning situation and an understanding of the materials for instruction, e.g. different texts, visual and audio tools including LMS software. Factor 3 was therefore named pedagogical content knowledge (PCK).

FACTOR 4

It is evident from the pattern matrix in Table 10 that items LMS-K1 to LMS-K10 have the highest loadings on factor 4. These items portray educators' technology knowledge (in this instance limited to LMSs) and define knowledge about LMSs, i.e. knowing how to manipulate and apply a variety of LMS-based tools and the ability to troubleshoot technical problems as they arise. Factor 4 was thus labelled LMS knowledge (LMS-K).

FACTOR 5

Items PK1 to PK8 asked subjects about a wide range of strategies, practices and methods of teaching that facilitate student learning as they apply generally across different subject domains. All of these items grouped on factor 5. Subsumed under this label then was pedagogical knowledge (PK).

FACTOR 6

Items LMS-PK1 to LMS-PK7 had the highest loadings on factor 4. These variables relate to educators' knowledge (content-free) about the tools and functions of the LMS and understanding how they might be used for instructional purposes, such as being able to use the LMS to design multiple forms of feedback online. Examples are incorporating announcements, automated SMSs or comments in the grade book. Factor 4 was therefore named LMS pedagogical knowledge (LMS-PK).

A summary of the validity results in Table 12 shows that the items in the self-reporting questionnaire can be grouped into six factors (constructs), namely LMS-TPACK, CK, PCK, LMS-K, PK and LMS-PK, which reflect both the theoretical and conceptual intent as anticipated from LMS-TPACK. Section B was not included in the factor analysis as it comprised biographical information.

Table 12: *Final grouping of items into LMS-TPACK constructs*

Factor/constructs	Items Removed	Items Retained
1 LMS-TPACK (*blend* of LMS-CK and LMS-TPACK items)	LMS-CK7; LMS-TPACK4	LMS-CK1, 2, 3, 4, 5, 6, 8 LMS-TPACK1, 2, 3, 5, 6, 7, 8
2 Content knowledge (CK)	None	CK1, 2, 3, 4, 5, 6, 7, 8
3 Pedagogical content knowledge (PCK)	None	PCK1, 2, 3, 4, 5, 6, 7, 8
4 LMS knowledge (LMS-K)	None	LMS-K1, 2, 3, 4, 5, 6, 7, 8, 9, 10
5 Pedagogical knowledge (PK)	None	PK1, 2, 3, 4, 5, 6, 7, 8
6 LMS pedagogical knowledge (LMS-PK)	LMS-PK8	LMS-PK1, 2, 3, 4, 5, 6, 7

5.6 RELIABILITY

Once the number of factors (or constructs) was confirmed, an item analysis was done on each identified construct and the overall instrument. Items LMS-CK7, LMS-TPACK4 and LMS-TP8 were excluded from the reliability analysis. The goal here was to ascertain whether each of the items made a significant contribution to its unique construct (scale). In instances where items correlated very low or negatively with the overall score from that particular construct or scale (i.e. values less than about .3), items were dropped (Field, 2013).

An additional goal of item analysis is to compute the reliability coefficient. Cronbach's alpha was calculated for each single LMS-TPACK construct and for the whole instrument. Alpha was computed twice: when all the items were retained and when particular items were dropped. Depending on the values of the columns labelled *Corrected Item-Total Correlation* and *Cronbach's Alpha if Item Deleted*, it was then decided whether a particular item(s) should be retained or deleted to improve construct reliability (Field, 2013). Detailed results from the item analysis are provided in Tables 13 to 19.

Tables 13(a) – (d): *Item analysis of the construct LMS-TPACK (factor 1)*

Table 13(a): Case processing summary

		N	%
Cases	Valid	298	89.8
	Excluded[a]	34	10.2
	Total	332	100.0

a. Listwise deletion based on all variables in the procedure

Table 13(b): Reliability statistics

Cronbach's Alpha	N of Items
.955	14

Table 13(c): Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I know how to use myUNISA to…				
LMS-CK1 direct students to *web-based content* (e.g. access content through RSS feeds to online publishers, libraries)	43.30	136.923	.747	.952
LMS-CK2 integrate third party software/tools to communicate *concepts* (e.g. AutoCAD, GIS, DrGeo, Math Blaster, KGeography, Bookkeeper)	44.12	141.736	.639	.955
LMS-CK3 demonstrate unobservable, obscure *concepts* invisible to the eye (e.g. using illustrations, simulations, games, mind mapping)	43.68	137.173	.762	.952
LMS-CK4 transform the *content* (e.g. running an online video or simulation is different from reading printed text)	43.63	135.593	.815	.951
LMS-CK5 offer flexible access across multiple representations (e.g. move between text, graphs, diagrams, videos, formulas)	43.61	134.569	.834	.950
LMS-CK6 chunk the *content* (e.g. split or break content into several smaller segments)	43.34	135.490	.763	.952
LMS-CK8 afford students opportunities to actively engage with the *content* (e.g. foster *student-centred* learning)	42.90	140.747	.680	.954
I know how to…				
LMS-TPACK1 *combine teaching strategies* with *myUNISA tools* to *transform the content* (e.g. problem-based learning, experiential learning, activity-based learning)	43.03	139.123	.791	.951
LMS-TPACK2 clarify *difficult concepts* by *selecting myUNISA tools* that afford different forms of *representation* (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	43.27	136.781	.809	.951
LMS-TPACK3 integrate *myUNISA tools* and *web-based content* to support *blended* learning (e.g. a combination of print, other media)	43.11	137.441	.785	.951
LMS-TPACK5 guide students to *web-based content* by making use of *myUNISA tools* that provide opportunities for *flexible learning* (e.g. students can learn and access materials at own time, place and space)	43.00	137.990	.789	.951
LMS-TPACK6 integrate *myUNISA tools* that allow students' to participate in online *discussions related to content* (e.g. discussion forums, blogs, wikis)	42.88	139.245	.734	.952
LMS-TPACK7 use a *team approach* to integrate *pedagogy*, *content* and *myUNISA tool* use in the design of the module (e.g. complete certificate of due diligence)	43.16	136.894	.727	.953
LMS-TPACK8 combine *content* and *myUNISA tools* to provide students opportunities to *interactively engage* as part of their learning (e.g. students input/respond to online activities, assessments, discussions)	42.92	138.461	.754	.952

Note: LMS-CK and LMS-TPACK items loaded as a single factor (construct)

Table 13(d): Scale statistics

Mean	46.61
Variance	159.181
Standard deviation	12.617
Number of items	14

Tables 13(a) - 13(d) shows the results of the reliability analysis for the LMS-TPACK subscale. The value of α is .955 which, according to George and Mallery (2003), suggests excellent reliability. All the items in the *Corrected Item-Total Correlation* column are well above .3 and all of the values labelled *Cronbach's Alpha if Item Deleted* are around a similar value to overall α (.955). These results indicate stable internal consistency and so all items in this category were retained.

Tables 14(a) – (d): *Item analysis of the construct CK (factor 2)*

Table 14(a): Case processing summary

		N	%
Cases	Valid	323	97.3
	Excluded[a]	9	2.7
	Total	332	100.0

a. Listwise deletion based on all variables in the procedure

Table 14(b): Reliability statistics

Cronbach's Alpha	N of Items
.920	8

Table 14(c): Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I have knowledge of…				
CK1 the *curriculum content* in my discipline (e.g. set of courses/modules that make up a full programme)	32.11	10.983	.554	*.926
CK2 *key facts* in my discipline	31.99	10.689	.761	.908
CK3 *basic concepts* in my discipline (e.g. language, terminology, labels)	31.95	11.056	.763	.909
CK4 *fundamental theories* that underpin my discipline (e.g. philosophies, rules, models, principles)	32.07	10.619	.784	.906
CK5 various *techniques/procedures* in my discipline (e.g. methods, ways of doing things)	32.10	10.555	.819	.903
CK6 what constitutes *legitimate knowledge* in my discipline (e.g. distinguish between correct and incorrect knowledge; fact and opinion)	32.10	10.431	.775	.906
CK7 how to select *content for teaching* that meet requirements of accredited professional/ educational standards/bodies in my discipline	32.18	10.245	.723	.912
CK8 *central topics* taught in my discipline	32.04	10.874	.753	.909

Table 14(d): Scale statistics

Mean	36.65
Variance	13.794
Standard deviation	3.714
Number of items	8

For the CK subscale, the reliability analysis results are displayed in Tables 14(a) to (d). The overall reliability is .920, which is excellent and in keeping with George and Mallery's views (2003). The values in the column labelled *Corrected Item-Total Correlation* are all above .3 and values in the column named *Cronbach's Alpha if Item Deleted* are all around .920, except *CK1 (.926), which is not significantly greater than the overall alpha when the item is left out. As a result, all the items were retained.

Tables 15(a) – (d): *Item analysis of the construct PCK (factor 3)*

Table 15(a): Case processing summary

		N	%
Cases	Valid	319	96.1
	Excluded[a]	13	3.9
	Total	332	100.0

a. Listwise deletion based on all variables in the procedure

Table 15(b): Reliability statistics

Cronbach's Alpha	N of Items
.930	8

Table 15(c): Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Without using myUNISA tools, I know how to…				
PCK1 address *misconceptions* students might have about the content (e.g. misunderstandings, mistaken beliefs)	27.90	31.971	.647	.929
PCK2 select *instructional strategies* that *fit the content* (e.g. group work, activity-based learning, experiential learning)	28.08	30.053	.729	.923
PCK3 *pace* learning so students are able to *master the content* (e.g. timed readings, timed assessments)	28.06	30.191	.744	.922
PCK4 *address concepts/topics* students are likely to find *easy or difficult* about the content	27.90	30.043	.824	.916
PCK5 *design interactive content* for students to input or respond to (e.g. students input or respond to self-assessments, quizzes to generate a result)	28.22	29.503	.714	.925
PCK6 *link* students *prior knowledge* to the *content* (e.g. use introductory entry level activities, set baseline assessments)	28.09	29.706	.820	.916
PCK7 *represent* the *content* in multiple ways (e.g. useful analogies, illustrations, examples, explanations)	27.96	30.162	.777	.919
PCK8 make *connections* between various *concepts/topics/related modules*	27.92	30.063	.836	.915

Table 15(d): Scale statistics

Mean	32.02
Variance	39.069
Standard deviation	6.251
Number of items	8

The results for the reliability analysis for the PCK subscale are displayed in Tables 15(a) to (d) and show an overall reliability of .930, which again indicates excellent reliability (George & Mallery, 2003). The values of items in the *Corrected Item-Total Correlation* column are above .3 and those in the column labelled *Cronbach's Alpha if Item Deleted* are around a similar value to α (.930). Yet again, results identify stable internal consistency; therefore all items in this construct were retained.

Tables 16(a) – (d): *Item analysis of the construct LMS-K (factor 4)*

Table 16(a): Case processing summary

		N	%
Cases	Valid	310	93.4
	Excluded[a]	22	6.6
	Total	332	100.0

a. Listwise deletion based on all variables in the procedure

Table 16(b): Reliability statistics

Cronbach's Alpha	N of Items
.905	10

Table 16(c): Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I know how to…				
LMS-K1 modify/personalize the default *Homepage*	36.01	59.702	.673	.895
LMS-K2 upload *Official Study Material* (e.g. Tutorial Letters, Study Guides, previous exam papers)	35.83	60.848	.625	.898
LMS-K3 upload *Prescribed Book Lists* (e.g. display prescribed books, recommended readings, e-reserves)	35.97	61.113	.609	.899
LMS-K4 publish discussions using the *Discussion Forums tool* (e.g. add module discussion activities, create topics to discuss assignment/exam queries)	35.63	62.830	.685	.896
LMS-K5 post information using the *Announcements tool* (e.g. post messages on module site that can also be mailed to the class)	35.55	63.466	.691	.896
LMS-K6 customize the *Schedule tool* (e.g. for posting and viewing deadlines, events related to a course)	36.45	59.731	.634	.898
LMS-K7 upload *Additional Resources* (e.g. class notes, multimedia files)	35.77	60.574	.755	.891
LMS-K8 track assignments using the *Assignments tool* (e.g. assignment statistics, MCQ marking reports, assignment status reports, marking statistics)	36.15	58.830	.721	.892
LMS-K9 export statistical reports using the *Statistics tool* (e.g. user visits, tool and resource activity)	36.69	57.702	.672	.896
LMS-K10 update module site settings using the *Site Info tool*	36.55	57.976	.660	.897

Table 16(d): Scale statistics

Mean	40.07
Variance	73.643
Standard deviation	8.582
Number of items	10

The overall reliability of the LMS-K subscale as shown in Table 16(b) is .905, which is an indication of excellent reliability (George & Mallery, 2003). All the items in this construct were retained since the values of the items in the *Corrected Item-Total Correlation* column and the *Cronbach's Alpha if Item Deleted* column were adequate.

Tables 17(a) – (d): *Item analysis of the construct PK (factor 5)*

Table 17(a): Case processing summary

		N	%
Cases	Valid	320	96.4
	Excluded[a]	12	3.6
	Total	332	100.0

a. Listwise deletion based on all variables in the procedure

Table 17(b): Reliability statistics

Cronbach's Alpha	N of Items
.872	8

Table 17(c): Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I know how to…				
PK1 *design study material* for distance learning	28.72	19.588	.607	.859
PK2 *align* learning *outcomes, instruction* and *assessment*	28.60	19.387	.721	.847
PK3 *draw* from a range of *learning theories* (e.g. behaviourism, constructivism, cognitivism, etc.)	29.20	19.053	.520	*.873
PK4 *integrate* a mix of student *support strategies* (e.g. courseware, tutorials, feedback, practical work, sms, email)	28.71	19.453	.672	.852
PK5 *use* different *assessment strategies* (e.g. formative, summative assessments)	28.46	20.086	.693	.852
PK6 *facilitate* varied forms of *interactions* (e.g. between student-and-student, student-and-lecturer, student-and-tutor, student-and-content)	28.81	19.476	.600	.859
PK7 *sequence* learning *activities* (e.g. from simple to complex)	28.73	19.018	.697	.849
PK8 *link* instructional activities to *authentic experiences* (e.g. everyday real-life experiences)	28.67	19.965	.591	.860

Table 17(d): Scale statistics

Mean	32.84
Variance	25.016
Standard deviation	5.002
Number of items	8

Tables 17(a) – (d) show the results for the reliability analysis for the PK subscale. In this instance, α is .872, which is in the region identified by George and Mallery (2003) and indicates good reliability. Again, the values in the column labelled *Corrected Item-Total Correlation* and the values in the column named *Cronbach's Alpha if Item Deleted* are appropriate. Only *PK3 is .873, which is not significantly greater than the overall alpha (.872) when the item is left out. As a result, all the items were retained.

Tables 18(a) – (d): *Item analysis of the construct LMS-PK (factor 6)*

Table 18(a): Case processing summary

		N	%
Cases	Valid	322	97.0
	Excluded[a]	10	3.0
	Total	332	100.0

a. Listwise deletion based on all variables in the procedure

Table 18(b): Reliability statistics

Cronbach's Alpha	N of Items
.902	7

Table 18(c): Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I know how to use myUNISA to…				
LMS-PK1 to *orientate* students *online* (e.g. clarify outcomes, instruction and assessment criteria in module site)	21.88	27.823	.698	.890
LMS-PK2 *scaffold learning online* (e.g. guide students' learning from simple to more complex concepts/tasks)	22.08	26.850	.739	.885
LMS-PK3 *create assessments online* (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	22.28	25.272	.757	.882
LMS-PK4 *design feedback online* (e.g. electronic, sms, Announcements, emails, comments in the grade book)	22.01	26.589	.678	.891
LMS-PK5 varied forms of *representation online* (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	22.39	25.386	.751	.882
LMS-PK6 *monitor* student *learning online* (e.g. assignment submissions and marks, discussions, blogs)	22.05	26.904	.661	.893
LMS-PK7 *provide* for *diverse digital capabilities* of students online (e.g. module site interface functional for novice users, disabled users, sensitive to language)	22.74	25.703	.705	.888

Table 18(d): Scale statistics

Mean	25.90
Variance	35.3.02
Standard deviation	5.942
Number of Items	7

For the LMS-PK subscale, Table 18(b) shows an overall reliability of .902, which suggests excellent reliability (George & Mallery, 2003). All values in the column labelled *Corrected Item-Total Correlation* are above .3, which is positive, and values in the column labelled *Cronbach's Alpha if Item Deleted* show that none of the items here would increase the reliability if they were deleted. Thus, all the items in this construct were retained.

Tables 19(a) – (d): *Item analysis of the overall LMS-TPACK instrument*

Table 19(a): Case processing summary

		N	%
Cases	Valid	277	83.4
	Excluded[a]	55	16.6
	Total	332	100.0

a. Listwise deletion based on all variables in the procedure

Table 19(b): Reliability statistics

Cronbach's Alpha	N of Items
.961	55

Table 19(c): Item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
I know how to…				
LMS-K1 modify/personalise the default Homepage	209.98	937.934	.536	.961
LMS-K2 upload Official Study Material (e.g. Tutorial Letters, Study Guides, previous exam papers)	209.79	940.338	.521	.961
LMS-K3 upload Prescribed Book Lists (e.g. display prescribed books, recommended readings, e-reserves)	209.92	943.581	.476	.961
LMS-K4 publish discussions using the Discussion Forums tool (e.g. add module discussion activities, create topics to discuss assignment/exam queries)	209.59	946.068	.576	.960
LMS-K5 post information using the Announcements tool (e.g. post messages on module site that can also be mailed to the class)	209.50	950.490	.537	.961
LMS-K6 customize the Schedule tool (e.g. for posting and viewing deadlines, events related to a course)	210.40	932.648	.585	.960
LMS-K7 upload Additional Resources (e.g. class notes, multimedia files)	209.72	939.759	.618	.960
LMS-K8 track assignments using the Assignments tool (e.g. assignment statistics, MCQ marking reports, assignment status reports, marking statistics)	210.15	934.054	.592	.960
LMS-K9 export statistical reports using the Statistics tool (e.g. user visits, tool and resource activity)	210.69	924.325	.633	.960
LMS-K10 update module site settings using the Site Info tool	210.53	926.206	.610	.960
I know how to…				
PK1 design study material for distance learning	209.91	952.851	.482	.961
PK2 align learning outcomes, instruction and assessment	209.81	954.827	.485	.961
PK3 draw from a range of learning theories (e.g. behaviourism, constructivism, cognitivism, etc.)	210.38	955.346	.348	.961
PK4 integrate a mix of student support strategies (e.g. courseware, tutorials, feedback, practical work, sms, email)	209.90	949.522	.577	.960
PK5 use different assessment strategies (e.g. formative, summative assessments)	209.65	954.590	.539	.961
PK6 facilitate varied forms of interactions (e.g. between student-and-student, student-and-lecturer, student-and-tutor, student-and-content)	210.00	951.330	.502	.961
PK7 sequence learning activities (e.g. from simple to complex)	209.92	950.563	.524	.961
PK8 link instructional activities to authentic experiences (e.g. everyday real-life experiences)	209.86	957.110	.413	.961
I have knowledge of…				
CK1 the curriculum content in my discipline (e.g. set of courses/modules that make up a full programme)	209.48	965.577	.336	.961
CK2 key facts in my discipline	209.39	966.021	.361	.961
CK3 basic concepts in my discipline (e.g. language, terminology, labels)	209.34	967.284	.375	.961
CK4 fundamental theories that underpin my discipline (e.g. philosophies, rules, models, principles)	209.45	967.408	.327	.961

CK5 various techniques/procedures in my discipline (e.g. methods, ways of doing things)	209.47	966.018	.374	.961
CK6 what constitutes legitimate knowledge in my discipline (e.g. distinguish between correct and incorrect knowledge; fact and opinion)	209.47	965.786	.363	.961
CK7 how to select content for teaching that meet requirements of accredited professional/ educational standards/bodies in my discipline	209.54	962.249	.405	.961
CK8 central topics taught in my discipline	209.42	965.766	.401	.961
Without using myUnisa, I know how to…				
PCK1 address misconceptions students might have about the content (e.g. misunderstandings, mistaken beliefs)	209.91	960.397	.337	.961
PCK2 select instructional strategies that fit the content (e.g. group work, activity-based learning, experiential learning)	210.09	950.846	.448	.961
PCK3 pace learning so students are able to master the content (e.g. timed readings, timed assessments)	210.04	952.915	.436	.961
PCK4 address topics/concepts students are likely to find easy or difficult about the content	209.90	956.340	.393	.961
PCK5 design interactive content for students to input or respond to (e.g. students input or respond to self-assessments, quizzes to generate a result)	210.21	951.666	.403	.961
PCK6 link students prior knowledge to the content (e.g. use introductory entry learning level activities, set baseline assessments)	210.07	953.756	.437	.961
PCK7 represent the content in multiple ways (e.g. useful analogies, illustrations, examples, explanations)	209.94	957.671	.371	.961
PCK8 make connections between various concepts/topics/related modules	209.90	956.625	.407	.961
I know how to use myUNISA to…				
LMS-PK1 to orientate students online (e.g. clarify outcomes, instruction and assessment criteria in module site)	210.01	945.482	.602	.960
LMS-PK2 scaffold learning online (e.g. guide students' learning from simple to more complex concepts/tasks)	210.18	940.677	.647	.960
LMS-PK3 create assessments online (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	210.34	933.306	.650	.960
LMS-PK4 design multiple forms of feedback online (e.g. electronic, sms, Announcements, emails, comments in the grade book)	210.12	939.965	.582	.960
LMS-PK5 varied forms of representation online (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	210.47	930.170	.701	.960
LMS-PK6 monitor student learning online (e.g. assignment submissions and marks, discussions, blogs)	210.19	937.008	.634	.960
LMS-PK7 provide for diverse digital capabilities of students online (e.g. module site interface functional for novice users, disabled users, sensitive to language)	210.82	931.446	.666	.960
I know how to use myUNISA to…				
LMS-CK1 direct students to web-based content (e.g. access through RSS feeds to online publishers, libraries)	210.66	928.776	.681	.960
LMS-CK2 integrate third party software/tools to communicate concepts (e.g. AutoCAD, GIS, DrGeo, Math Blaster, KGeography, Bookkeeper)	211.49	940.635	.562	.960
LMS-CK3 demonstrate unobservable, obscure facts/concepts/principles invisible to the eye (e.g. using illustrations, simulations, games, mind mapping)	211.06	931.626	.656	.960
LMS-CK4 transform the content (e.g. running an online video or simulation is different from reading printed text)	211.01	927.775	.697	.960
LMS-CK5 offer flexible access across multiple representations (e.g. link text, graphs, diagrams, videos, formulas)	210.99	925.645	.709	.960
LMS-CK6 chunk the content (e.g. split or break content into several smaller segments)	210.72	926.201	.681	.960
LMS-CK8 afford students opportunities to actively engage with the content (e.g. foster student-centred learning)	210.30	937.111	.635	.960
I know how to…				
LMS-TPACK1 combine teaching strategies with myUNISA tools to transform the content (e.g. problem-based learning, experiential learning, activity-based learning)	210.44	933.117	.735	.960
LMS-TPACK2 clarify difficult concepts using/by selecting myUNISA tools that afford different forms of representation (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	210.68	930.256	.709	.960
LMS-TPACK3 integrate myUNISA tools and web-based content to support blended learning (e.g. a combine print, other media)	210.53	930.040	.709	.960
LMS-TPACK5 guide students to web-based content by making use of myUNISA tools that provide opportunities for flexible learning (e.g. students can learn and access materials at own time, place and space)	210.40	931.292	.717	.960
LMS-TPACK6 integrate myUNISA tools that allow students' to participate in online discussions related to content (e.g. discussion forums, blogs, wikis)	210.31	932.583	.699	.960

LMS-TPACK7 use a team approach to integrate pedagogy, content and myUNISA tools in the design of the module (e.g. complete certificate of due diligence)	210.57	927.232	.682	.960
LMS-TPACK8 combine content and myUNISA tools to provide students opportunities to interactively engage as part of their learning (e.g. students input/respond to online activities, assessments, discussions)	210.33	932.533	.688	.960

Table 19(d): Scale statistics

Mean	214.02
Variance	979.351
Standard deviation	31.295
Number of Items	55

Finally, Table 19(b) displays a reliability coefficient of .961, which suggests excellent reliability (George & Mallery, 2003) for the whole instrument. All values in the column labelled *Corrected Item-Total Correlation* are above .3, which is encouraging, and values in the column labelled *Cronbach's Alpha if Item Deleted* show that none of the items here would increase the reliability if they were deleted since all values in this column are less than .961. All 55 items in the LMS-TPACK questionnaire were retained. A summary of the reliability coefficients for each construct as well as the overall LMS-TPACK scale is given in Table 20.

Table 20: *Reliability coefficients (Cronbach's alpha) for each LMS-TPACK construct*

Construct	**Number of Items**	**Items Left Out**	**Cronbach's Alpha *(α)***	**Reliability**
LMS-K	10	None	.905	Excellent
PK	8	None	.872	Good
CK	8	None	.920	Excellent
PCK	8	None	.930	Excellent
LMS-PK	7	None	.902	Excellent
LMS-CK/LMS-TPACK	14	None	.955	Excellent
Whole instrument	55	None	.931	Excellent

Note: N = 332

According to George and Mallery (2003), the construct PK (α = .872) has good reliability, whereas all the other subscales, namely LMS-K (α = .905), CK (α = .920), PCK (α = .930), LMS-PK (α = .902) and LMS-TPACK (α = .955), have excellent reliability. Additionally, the overall coefficient alpha for the entire survey instrument was found to be .931. Every distinct construct, including the overall instrument scale, was therefore deemed to be reliable in measuring the anticipated LMS-TPACK.

5.7 SUMMARY

In conclusion, the data gathered during this study indicate that the instrument is both valid and reliable. Factor analysis was done and six out of the seven widely accepted theorised TPACK constructs were identified after the eigenvalues, cumulative variance extracted and the significant decline in the scree plot were examined. LMS-CK and LMS-TPACK loaded as a single construct, thereby suggesting that subjects may have had difficulty distinguishing between the items. LMS-CK was the only construct in the LMS-TPACK structure that did not show up as anticipated. Item analysis was also carried out to assess the reliability of the different constructs in the questionnaire. Internal consistency among the different constructs was strong. The resulting Cronbach's alpha coefficients for each construct and the overall scale advocate compelling evidence for stable internal consistency reliability.

The research objectives as presented in this section have been achieved. A discussion of the results, conclusions drawn and their implications for theory and practice, as well as limitations and recommendations for future research will be discussed in Chapter 6.

CHAPTER SIX

DISCUSSION, CONCLUSION AND FUTURE RESEARCH

6.1 INTRODUCTION

As distance education is continuing to grow, massive online development has been set in motion at UNISA, especially through the proliferation of an LMS-based virtual teaching and learning environment. A salient feature of this trend relates to the growing numbers of ODL educators who are being called upon to be ready to apply different forms of knowledge for effective integration of LMS for teaching and learning. In an effort to evaluate educators' knowledge, this study adopted Mishra and Koehler's Technological Pedagogical Content Knowledge (TPACK) framework (2006) to develop and validate a new reliable instrument for assessing ODL educators' perceived LMS-TPACK. TPACK describes the various forms of knowledge required by educators for meaningful technology integration in teaching, i.e. what educators need to know, understand and do. In this chapter, the research methods and key findings are summarised and the implications for both theory and practice illuminated. The researcher outlines some key limitations that relate to the study and recommends directions for future research.

6.2 METHODS AND RESULTS

The main objective of this research was to develop a valid and reliable instrument for assessing ODL educators' perceived LMS-TPACK. The secondary goals were to (1) determine what constructs and underlying dimensions needed to be measured to ascertain LMS-TPACK and (2) establish whether the measuring instrument developed was valid and reliable for measuring the seven TPACK constructs described by Mishra and Koehler (2006). The study achieved these objectives by means of a critical analysis of available TPACK literature and the application of several rigorous methodical validation and reliability procedures.

The research questions originally put forward for this study were:

(a) What are the *constructs* and *underlying dimensions* that need to be measured to ascertain LMS-TPACK?

(b) Will the measuring instrument developed be *valid* and *reliable* for measuring the seven TPACK constructs described by Mishra and Koehler?

In answering the first research question relating to the constructs and underlying dimensions, firstly, the TPACK constructs of Mishra and Koehler (2006) were examined to increase current understanding of the various domains of knowledge they address, and secondly, literature describing ODL, LMSs and institutional policies were analysed to help identify features that characterise effective LMS integration in distance teaching. Thirdly, existing assessment instruments developed for measuring the TPACK of teaching staff were scrutinised, while some items were adapted and numerous new ones developed (Archambault & Crippen, 2009; Dinh, 2013; Lee & Tsai, 2010; Lux et al., 2011; Koh et al., 2014; Schmidt et al., 2009; Yurdakul et al., 2012). Following the construction of the LMS-TPACK instrument, a focus group, expert review and a pre-test were conducted to begin building a case for validity.

In answering the first part of the second research question concerning validity, six of the seven theorised TPACK constructs appeared in the responses of educators' perceived LMS-TPACK. The resulting factor solution grouped six distinct constructs as described by Mishra and Koehler (2006), namely LMS-K (TK), PK, CK, PCK, LMS-PK (TPK) and LMS-TPACK (TPACK). Contrariwise, all of the LMS-CK items, including the LMS-TPACK items, loaded as a single factor. This occurrence suggests that perhaps (1) subjects had difficulty distinguishing between the LMS-CK and LMS-TPACK items, or (2) the writing of items did not discriminate sufficiently between the two constructs, (3) the two constructs are inherently the same or (4) LMS-CK (TCK) simply does not exist in the TPACK understandings of the sample population (Hofer & Harris, 2012; Lux, 2010). LMS-PK8 (<.40) and LMS-CK7 (-.409) did not load onto any one factor and LMS-TPACK4 cross-loaded and was thus not retained for interpretation. EFA provided evidence for the instrument's internal structure and showed how the items related to one another and how the different constructs or items were interrelated.

In answering the second part of the second research question concerning the internal consistency of the educators' responses to the LMS-TPACK survey, statistical analysis suggests excellent reliability of the final overall instrument, α.= .931. The resulting Cronbach's alpha coefficients for the six different constructs varied, ranging from good to excellent (α = .872 to .955). The data analysis indicates stable internal consistency reliability among the items, constructs and the overall LMS-TPACK scale, suggesting that the developed instrument is valid and reliable for the purposes of assessing ODL educators' perceived LMS-TPACK.

6.3 IMPLICATIONS FOR THEORY AND PRACTICE

This study has the potential to impact current thoughts about the widely accepted theoretical components of TPACK and the manner in which TPACK ought to be operationalised to address comprehensive ODeL educator training. The discovery that LMS-CK failed to appear in the factor structure during factor analysis implies that added improvements need to be made to the theoretical model. This necessity involves a more meaningful analysis of the relationship between pedagogy and content.

Six of the seven theorised TPACK dimensions were revealed in the resulting factor structure. These are LMS knowledge (LMS-K), pedagogical knowledge (PK), content knowledge (CK), pedagogical content knowledge (PCK), LMS pedagogical knowledge (LMS-PK) and LMS technological pedagogical content knowledge (LMS-TPACK). However, the items that described LMS-CK cross-loaded with the LMS-TPACK scale, resulting in a single factor loading.

LMS-CK is knowledge associated with being a subject specialist (free of pedagogical strategies) and understanding how the LMS can be used to teach and bolster the content and how the nature of the content can be transformed. For example, running an online video or simulation on the LMS is different from reading printed text. While describing TCK (in this instance LMS-CK), Harris, Mishra and Koehler (2009) assert that educators must understand "the manner in which [LMS] and content influence and constrain one another"… and how content shapes or dictates LMS uses, and vice versa (pp. 399-400). This implies that LMS-CK is an advanced understanding where learning tasks drive LMS tool choices rather than educators deciding on tools at hand or continuing to add useless features and integrating LMS tools regardless of the goodness of fit.

Subsequent factor rotation optimised the factor solution and three items were removed, namely LMS-PK8, LMS-TPACK4 and LMS-CK7, as they either loaded too low (below .40) or cross-loaded. All the LMS-CK items and LMS-TPACK items which loaded significantly were retained and interpreted and labelled LMS-TPACK as this reflected both the theoretical and conceptual intent. This inconsistency or implied absence of LMS-CK in in-service ODL educators' perceptions of LMS-TPACK can possibly be attributed to a number of reasons.

Firstly, in-service ODL educators might be directing more of their attention to LMS tools and pedagogy than content, thus being more focused on their LMS-K and PK, rather than LMS content knowledge (LMS-CK). This might be especially true as educators participate in myUNISA LMS training to gain technical skills and develop essential instructional strategies, such as e-facilitation skills, skills for managing myUNISA virtual learning environment, designing online assessments and acquiring appropriate strategies to improve student engagement, thus causing LMS-CK to be less perceivable.

Secondly, professional development interventions concerning technology integration still remain largely technocentric (Harris et al., 2009) and focus mainly on general uses of technology rather than content-specific applications. As a consequence of this prominence, educators might find that they are paying more attention to *how* to teach with the LMS tools (pedagogy) rather than *what* to teach with the tools (content) brought about by conventional technology training routines. This could also mean that once training is complete, the onus then lies on individual educators to integrate general LMS-based tools with specific content in their pedagogic practice.

Swan and Hofer (2011) explored how teachers' podcasting integration choices helped students master their economic content. They found that teachers in their study lacked TCK (i.e. podcasting content knowledge) and were not able to make strategic connections between podcasting technology and economic content. This, they argued, was attributed mainly to the universal nature of podcasting technology as a means of communication rather than as a tool for constructing understanding. This might explain why ODL educators lack LMS-CK and why they do not have knowledge of appropriate LMS-based tools for addressing specific content areas that are devoid of pedagogy. On the other hand, Chai, Koh and Tsai (2013) argue that while universal technologies can be adapted for teaching and learning, these varieties of technologies are demanding on teachers' design capabilities, especially when they have to repurpose the tools.

Thirdly, analysis of the LMS-CK and LMS-TPACK scales suggests that perhaps educators were not able to discriminate between the two constructs. This lack of LMS-CK might have related to the way in which the items were written. Although the LMS-CK items were intended to assess educators' perceptions of knowledge of the relationship between LMS (technology) and content, the items did not clearly address the anticipated association. Instead, the wording of the items blurred the anticipated association, thereby impeding educators' ability to detect LMS-CK. For example, by using words such as "direct students to web-based content" and "chunk the content" the researcher unintentionally pedagogised the content. In other words, the LMS-CK items highlighted a range of ways that the LMS can possibly be used to augment or support the pedagogical knowledge or actions of educators without linking to any unique content-specific areas. Koehler, Mishra, Kereluik, Shin and Graham (2014) note that one significant limitation with the TPACK framework is its neutrality with regard to content.

One final observation as regards the theoretical implications of the findings could be that LMS-CK (TCK) simply does not exist in the educators' understanding (Hofer & Harris, 2012; Lux, 2010). Perhaps educators coincidentally incorporate their LMS-CK with their curriculum knowledge, i.e. knowledge of instructional materials including software packages that serve as tools for educators. Deng (2007) emphasises that curriculum knowledge does not only comprise content knowledge. As a result, in-service ODL educators' LMS content knowledge (LMS-CK) may well be a subdomain of their pedagogical content knowledge (PCK), given the curriculum-specific nature of the myUNISA LMS-based tools such as setting up a Homepage, using blogs and online discussions and assessments. In this sense, the myUNISA LMS has come to consist of curricular materials in distance education similar to traditional tutorial letters, study guides, textbooks and other "tools of the trade" (Shulman, 1987). In his conceptualisation of PCK, Shulman (1986; 1987) proposes that educators' knowledge of educational materials and structures comprise both tools (e.g. LMS) and contextual conditions. Robertson (2008) is of the opinion that technology integration efforts ought to focus on technology's relevance to content (its usefulness) and pedagogy.

> *…there is no such thing as an educationally-important "TC:" one cannot have meaningful expressions of technological content in education without first having a specific set of students, goals, and environment in mind (pedagogy)* (p. 2219)

Additionally, the research findings have important practical implications, especially for the area of professional development and support, which might need to be modified to better prepare future ODeL educators' LMS integration practices. As a first step, it might be useful for professional development support staff to reconsider the blend of LMS integration knowledge that educators ought to have. Besides advancing myUNISA LMS technical skills and online pedagogies, professional development support staff also need to provide educators with hands-on opportunities to link general to more focused uses of the myUNISA LMS, especially its application in respect of specific content areas. Modelling how the LMS can be used to teach and bolster specific content and illustrating how the nature of that specific content might be transformed could be one way of explicitly shifting educators' non-specific LMS content understanding to more specific LMS content knowledge. Shifting attention from *how* to teach using the LMS to *what* to teach using the LMS can help educators acquire LMS-CK (Hofer & Harris, 2012).

Moreover, the LMS-TPACK survey also provides a promising data collection tool that can be used to assess educators' knowledge, i.e. what they know, understand and are able to teach (specific content) using the LMS. The same survey could also be given as a pre- and post-test to (1) measure educators' achievement before and after attending training, (2) determine any change in their LMS-TPACK since the first test, (3) ascertain the effectiveness of training interventions and (4) identify areas for programme improvement. Test results can be used as a rationale to support the ongoing facilitation and training actions to be taken to develop educators' LMS-TPACK. It might also be possible through use of the new instrument to more closely scrutinise and identify with better validity and reliability educators' different domains of LMS-TPACK.

Finally, it is hoped the LMS-TPACK instrument can be valuable for promoting reflective critical thinking. Perhaps it can be used as a metacognitive tool so that educators can become aware of their own knowledge - what they do and do not know. Also, the LMS-TPACK instrument can serve as a helpful guide to assist educators in identifying features that characterise effective meaningful LMS integration in distance teaching. As a result, educators can begin to analyse and make judgements about their own developments. Pope and Golub (2000) note that educators need "to be critical consumers of technology, to be thoughtful users who question, reflect, and refract on the best times and ways to integrate technology" (p. 93). However, in order to become "critical consumers", educators ought to become explicitly aware of the current understandings in LMS-K, LMS-CK, LMS-PK and LMS-TPACK (Hughes & Scharber, 2008). This metacognitive understanding of LMS-TPACK enables educators to improve their practice, learn something new and in turn make meaningful decisions for LMS integration.

6.4 LIMITATIONS

The objective of this empirical research was to develop and validate a new reliable instrument for assessing ODL educators' perceived LMS-TPACK. The study undertook to help improve current understanding and operationalisation of the widely accepted TPACK, particularly its application within a transitioning ODL context. Although it is clear from this study that there is now a new valid reliable instrument for assessing ODL educators' perceived LMS-TPACK, several limitations of the instrument development and validation should be noted that suggest directions for future research.

Firstly, despite the fact that rich quantitative data were obtained, results were limited as educators provided numerical responses of their perceptions rather than detailed descriptions, offering less elaborate accounts of their knowledge. Use of pre-set response options may not necessarily have reflected the actual perceptions of educators' LMS-TPACK and in some instances could just have been the closest match. Additionally, Likert scale items may possibly have been interpreted differently by various respondents.

Secondly, the survey results relied heavily upon self-reported data obtained from the LMS-TPACK questionnaire. ODL educators were asked to rate their perceived levels of agreement with statements about their LMS-TPACK. A potential drawback of this design is that there are concerns of inaccuracy in rating their knowledge as some individuals routinely misjudge their capabilities (Sitzmann et al., 2010). Responses could have been guessed, faked or answered in a socially desirable manner. Subjects could have chosen to respond in a manner that reflected what is perceived by the survey administrator as expected and not reflected their actual knowledge, thus impacting the credibility of the results of the LMS-TPACK instrument.

Thirdly, the data collected for this study were derived from purposeful sampling. Subjects were selected on the basis of those who were readily available and who willingly volunteered to join in the survey. This form of data may be subject to self-selection bias as the survey attracted responses from educators who may possibly already be familiar with and committed to using myUNISA and who might have the knowledge to respond positively to the survey, thereby influencing instrument validity and reliability. Since it was preferable to use a homogeneous sample, the research was carried out only on educators situated in a single ODL institution who had LMS knowledge and experience; as a consequence, results of this study may not be generalised beyond the relevant population.

Finally, data for this study were collected using a cross-sectional survey design. Although results reflect large-scale assessment of educators' current perceptions, the survey was carried out at one point in time only and therefore data may not be as robust as data collected over a longer period. Also, it was impossible to consider every influential factor due to the complexity of educator knowledge. The categories of knowledge as presented in the instrument list only the key outcomes of the current study and may be expanded as needed in the future. The findings of this study need to be interpreted within the limitations specified above.

6.5 RECOMMENDATIONS FOR FUTURE RESEARCH

The following recommendations have arisen out of the research limitations previously identified. Although findings suggest that the instrument developed is valid and reliable for assessing ODL educators' LMS-TPACK, quantitative measures may not fully reflect actual knowledge and practices. Reduction of data to numbers results in lost information, hence consideration needs to be given to using multiple sources of data collection. Qualitative and mixed method designs can be used to further explore and gain a deeper understanding of the complexity of educators' knowledge while integrating an LMS into teaching and learning.

A further possibility for future research may be to include alternative measures such as interviews, performance- and portfolio-based assessments, expert assessments and peer reviews (Angeli & Valanides, 2009, McMillan & Schumacher, 2010). By observing hands-on LMS use, novice, intermediate and veteran educators' actions and teaching strategies can be compared and used to closely document the LMS-TPACK behind actual practices. Additionally, examining a portfolio of evidence such as course websites, lesson plans and students' work can help draw out more detail and illuminate different forms of knowledge and competence and the factors that may lead to effective LMS integration.

One aspect this research neglected to take account of was other stakeholders. Possibly asking students, policy makers and professional development support staff to rate educators' use of the LMS can offer more balanced clues about educators' LMS-TPACK. Additional varieties of involvement in and engagement with the broader UNISA community in the form of focus group discussions and workshops can improve understanding of the relationships between the LMS, pedagogy and content and help identify instances of meaningful effective integration practices. In this way, incorporating differing perspectives, experiences and expertise can help to get the knowledge mix right so that LMS-TPACK is better able to be identified, described and measured.

Finally, educators' perceptions of their LMS-TPACK can vary and evolve over time, both as a consequence of added training and number of years of teaching experience (Shulman, 1987; Mishra & Koehler, 2006). As a result, longitudinal studies are needed to observe the same educators who participated in this study over a longer period to gain a more comprehensive representation of their LMS-TPACK. Longitudinal studies can also involve pre- and post-tests in which educators' perceptions of LMS-TPACK can be measured before and/or after attending training interventions. In an attempt to more fully address the LMS-TPACK construct, perhaps it is possible to tease out and adapt the LMS-CK scale and improve the formulation of items to unambiguously address the teaching of content-specific areas using LMS, without pedagogising the content.

6.6 CONCLUSION

The main objective of the research was to develop and validate a new reliable instrument for the purposes of assessing ODL educators' perceived LMS-TPACK. The research results have revealed that the survey instrument is valid and reliable for assessing ODL educators' LMS-TPACK. Moreover, the results indicate that the anticipated sub-domain LMS-CK (TCK) might not exist in practice, thereby confirming prior studies (Hofer & Harris, 2012; Lux, 2010; Robertson, 2008). By contrast, findings in this study distinguished between educators' perceived knowledge in the other TPACK domains, namely LMS-K, PK, CK, PCK, LMS-PK and LMS-TPACK. TPACK is a multifaceted construct that can offer professional development support staff a framework to address effective meaningful integration of an LMS into distance teaching. More specifically, the model advocates that it is incumbent upon professional development support staff to guide in-service future ODeL educators toward understanding how the LMS, subject matter and pedagogy work together. This can possibly give rise to a category of professional knowledge (Shulman, 1986; 1987) that distinguishes ODeL educators from other educators. The acquisition of isolated LMS training does not address what the researcher believes is critical to effective meaningful LMS integration. Instead, educators need to acquire the kind of nuanced understanding called for by TPACK. It is hoped that the outcome of this study will mean a major redirection in how effective LMS integration is to be conceptualised and educators are to be trained and appraised in online distance teaching and that the instrument can aid in some of this work.

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APPENDIX A: Ethical clearance, Wits

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

Student Number: 677475

Protocol Number: 2014ECE005M

26 March 2014

Dear Mrs Michelle Luckay Van Wyk

Application for Ethics Clearance: Master of Education

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate has considered your application for ethics clearance for your proposal entitled:

ICTs in Higher Education are here, are we ready?

The committee recently met and I am pleased to inform you that clearance was granted.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely

MMabeta

Matsie Mabeta
Wits School of Education

011 717 3416

Cc Supervisor: Mr. Tom Waspe

APPENDIX B: Ethical clearance, College of Agriculture and Environmental Sciences, UNISA

UNISA university of south africa

2014-04-04

Ref. Nr.: 2014/CAES/107

To:
Applicant: Ms M Luckay
College of Agriculture and Environmental Sciences

Dear Ms Luckay

Request for Ethical approval for the following research project:

ICTs in Higher Education are here, are we ready?

The application for ethical clearance in respect of the above mentioned research has been reviewed by the Research Ethics Review Committee of the College of Agriculture and Environmental Sciences, Unisa. Ethics clearance for the above mentioned project (Ref. Nr.: 2014/CAES/107) **is given** for the duration of the study.

The application needs to go to SENRIC for approval to use UNISA staff as participants.

Please be advised that should any part of the research methodology change in any way as outlined in the Ethics application (Ref. Nr.: 2014/CAES/107), it is the responsibility of the researcher to inform the CAES Ethics committee. In this instance a memo should be submitted to the Ethics Committee in which the changes are identified and fully explained.

The Ethics Committee wishes you all the best with this research undertaking.

Kind regards,

Prof E Kempen,
CAES Ethics Review Committee Chair

Prof MJ Linington
Executive Dean: College of Agriculture and Environmental Sciences

Please note you need to apply to SHDRIC for approval for Academic/Unisa staff participation

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsmile: +27 429 12 429 4150
www.unisa.ac.za

APPENDIX C: Ethical clearance, Senate Research and Innovation and Higher Degrees Committee (SRIHDC), UNISA

UNISA university of south africa

PROF L LABUSCHAGNE
EXECUTIVE DIRECTOR: RESEARCH DEPARTMENT
Tel: *+27 12 429 6368 / 2446* ***Fax***: *+27 12 429 6960*
Email: *llabus@unisa.ac.za*
Address: *Theo van Wijk Building, 10th Floor, Office no. 50 (TvW 10-50)*

15 May 2014

Ms M Luckay
College of Agriculture and Environmental Sciences

Dear Ms Luckay

PERMISSION TO DO RESEARCH INVOLVING UNISA STAFF, STUDENTS OR DATA

A study into "ICTs in Higher Education are here, are we ready?"

Your application regarding permission to conduct research involving Unisa staff, students or data in respect of the above study has been received and was considered by the Unisa Senate Research and Innovation and Higher Degrees Committee (SRIHDC) on 17 April 2014.

It is my pleasure to inform you that permission has been granted for this study as set out in your application.

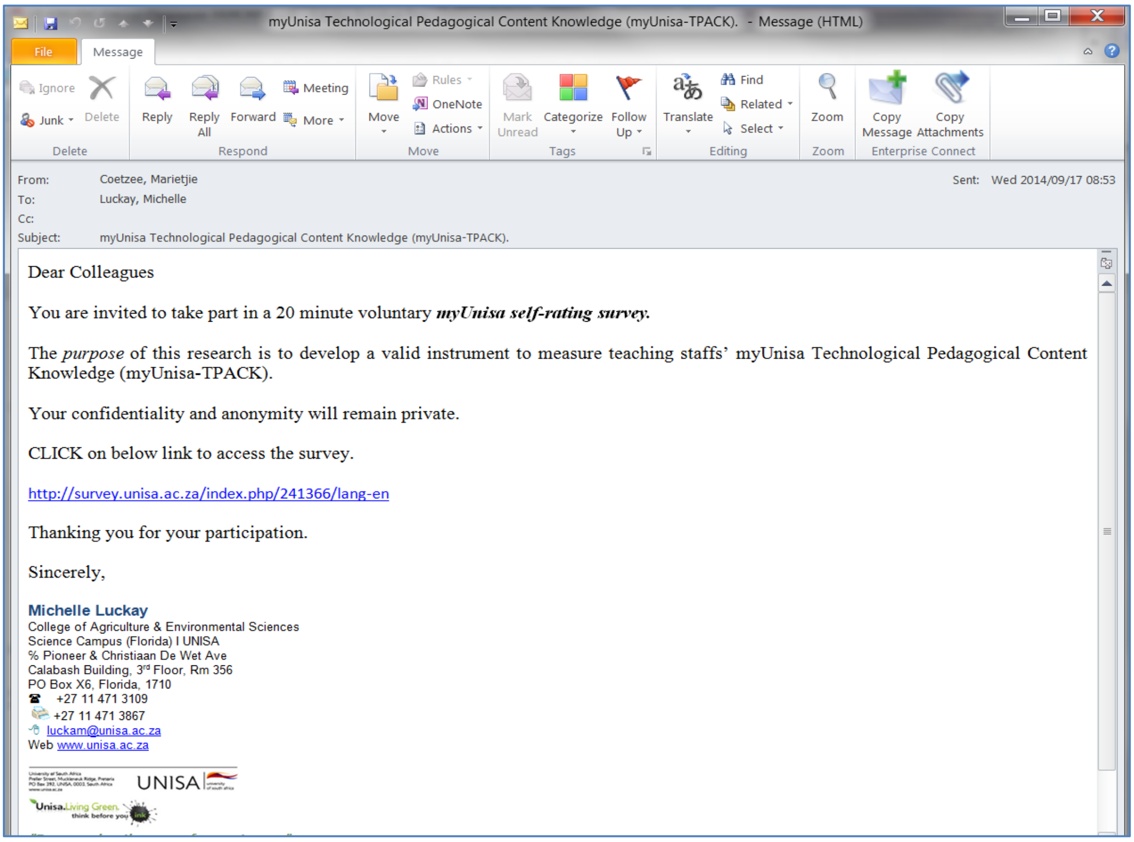
We would like to wish you well in your research undertaking.

Kind regards

PROF L LABUSCHAGNE
EXECUTIVE DIRECTOR: RESEARCH

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsmile: +27 429 12 429 4150
www.unisa.ac.za

APPENDIX D: Invitation to participate in LMS-TPACK survey



myUnisa Technological Pedagogical Content Knowledge (myUnisa-TPACK). - Message (HTML)

From: Coetzee, Marietjie
To: Luckay, Michelle
Cc:
Subject: myUnisa Technological Pedagogical Content Knowledge (myUnisa-TPACK).
Sent: Wed 2014/09/17 08:53

Dear Colleagues

You are invited to take part in a 20 minute voluntary ***myUnisa self-rating survey***.

The *purpose* of this research is to develop a valid instrument to measure teaching staffs' myUnisa Technological Pedagogical Content Knowledge (myUnisa-TPACK).

Your confidentiality and anonymity will remain private.

CLICK on below link to access the survey.

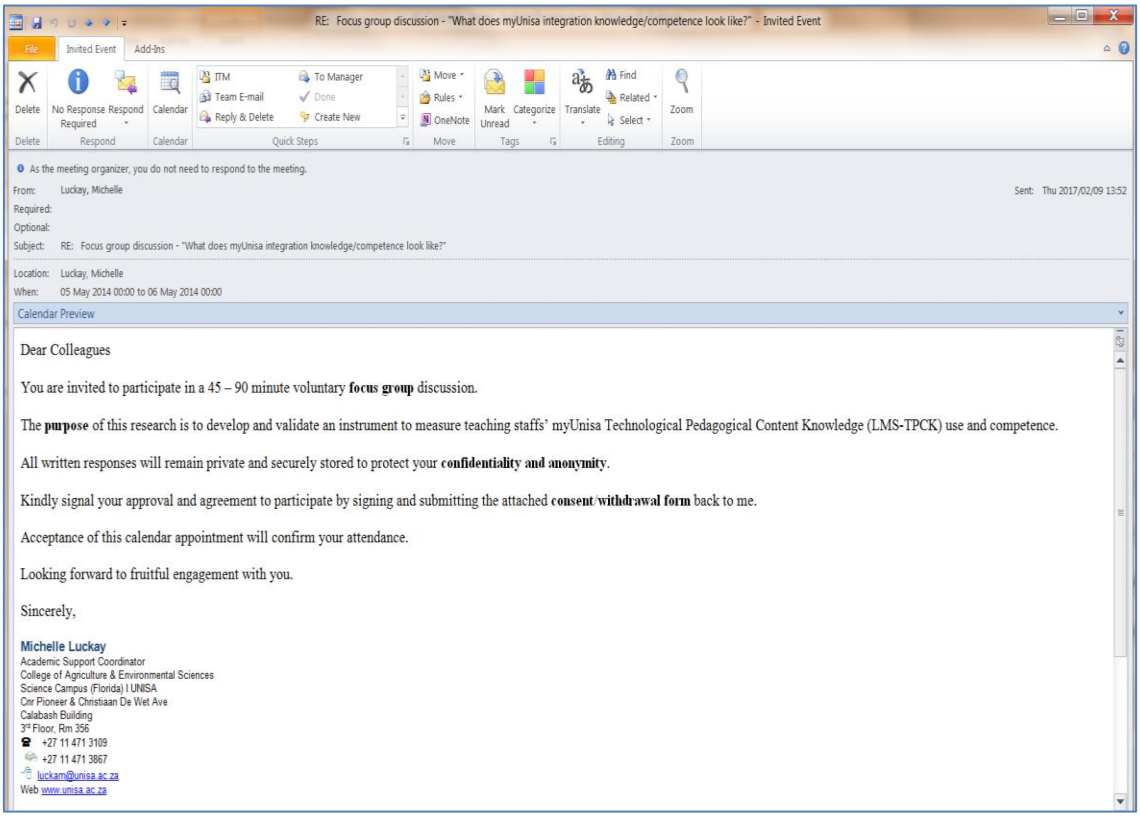
http://survey.unisa.ac.za/index.php/241366/lang-en

Thanking you for your participation.

Sincerely,

Michelle Luckay
College of Agriculture & Environmental Sciences
Science Campus (Florida) I UNISA
% Pioneer & Christiaan De Wet Ave
Calabash Building, 3rd Floor, Rm 356
PO Box X6, Florida, 1710
+27 11 471 3109
+27 11 471 3867
luckam@unisa.ac.za
Web www.unisa.ac.za

APPENDIX E: Invitation to participate in focus group discussion



RE: Focus group discussion - "What does myUnisa integration knowledge/competence look like?" - Invited Event

As the meeting organizer, you do not need to respond to the meeting.
From: Luckay, Michelle
Required:
Optional:
Subject: RE: Focus group discussion - "What does myUnisa integration knowledge/competence look like?"
Sent: Thu 2017/02/09 13:52
Location: Luckay, Michelle
When: 05 May 2014 00:00 to 06 May 2014 00:00

Dear Colleagues

You are invited to participate in a 45 – 90 minute voluntary **focus group** discussion.

The **purpose** of this research is to develop and validate an instrument to measure teaching staffs' myUnisa Technological Pedagogical Content Knowledge (LMS-TPCK) use and competence.

All written responses will remain private and securely stored to protect your **confidentiality and anonymity**.

Kindly signal your approval and agreement to participate by signing and submitting the attached **consent/withdrawal form** back to me.

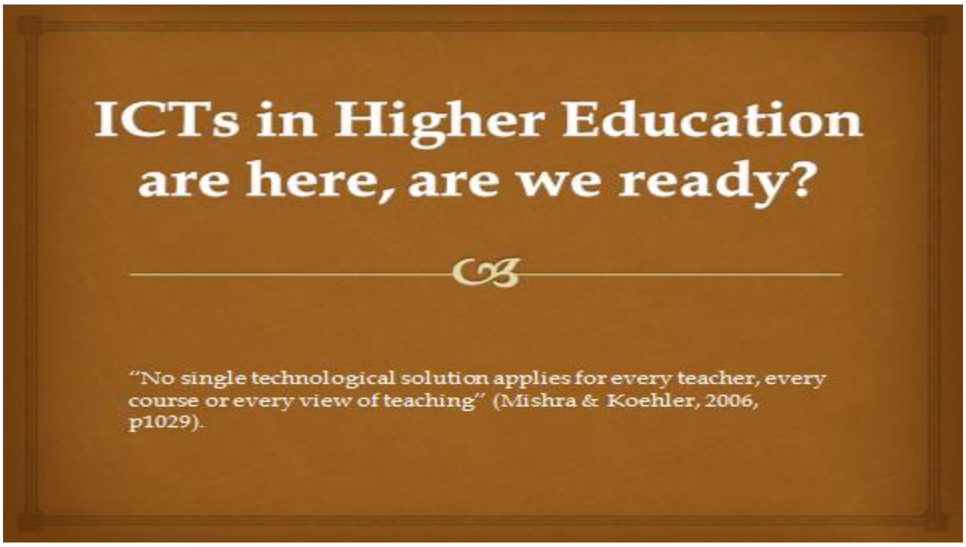
Acceptance of this calendar appointment will confirm your attendance.

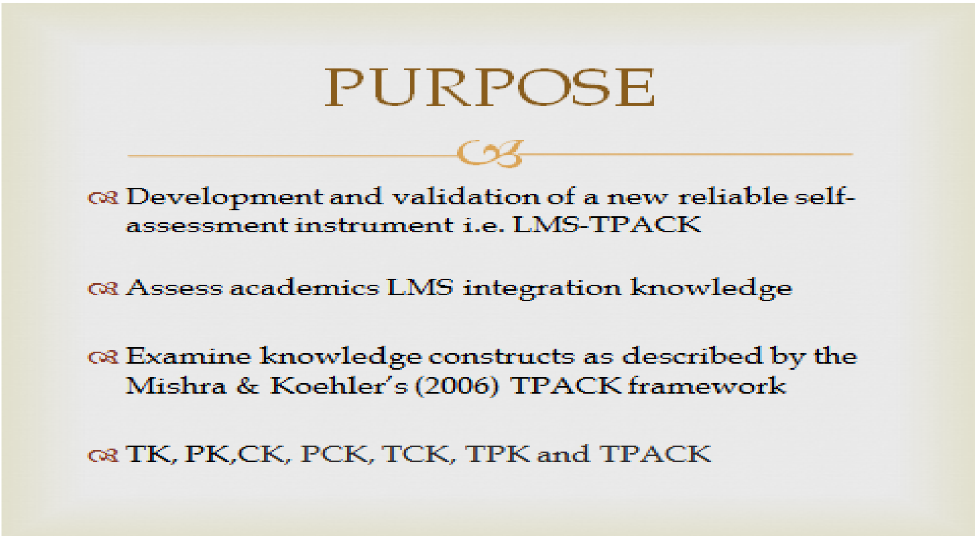
Looking forward to fruitful engagement with you.

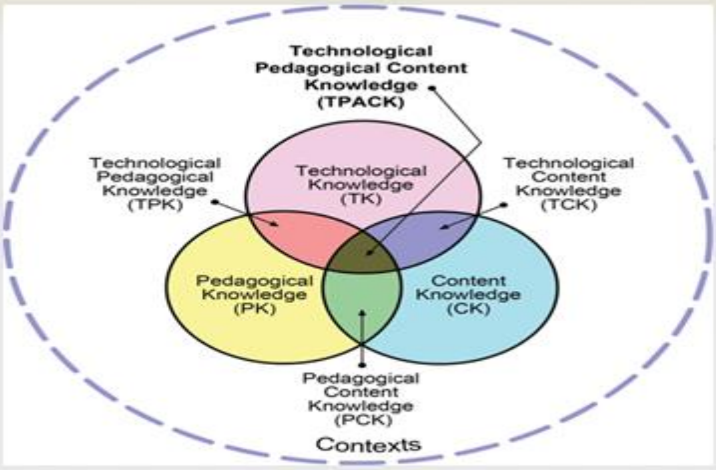
Sincerely,

Michelle Luckay
Academic Support Coordinator
College of Agriculture & Environmental Sciences
Science Campus (Florida) I UNISA
Cnr Pioneer & Christiaan De Wet Ave
Calabash Building
3rd Floor, Rm 356
+27 11 471 3109
+27 11 471 3867
luckam@unisa.ac.za
Web www.unisa.ac.za

APPENDIX F: TPACK PowerPoint presentation







Technological Pedagogical Content Knowledge
taken from the TPCK website: http://tpack.org

Key domains	Description
TK	Refers to knowledge about traditional and latest technologies. The **skills required to operate particular technologies**. About the "tools" (hardware, software) and "skills" (install, create, delete, archive, etc…). Continually changing so TK needs to **SHIFT** (learn and adapt)
PK	Refers to knowledge about a variety of **instructional practices, strategies and methods of teaching and learning**. It involves issues of student learning, lesson planning/implementation, classroom management, student evaluation. An understanding of **cognitive and developmental theories**
CK	**Subject matter** knowledge. Knowledge of **central facts, concepts, theories, and procedures** within the field. Teachers who do not have these understandings can misrepresent the subject.
PCK (Shulman, 1986 & 1987)	Knowing what **teaching approaches fit the content**. Knowing how content can be arranged for better teaching. Knowledge of what makes concepts difficult/easy to learn.
TPK	Knowledge of the **existence, components and capabilities** of various technologies **for teaching and learning**. How teaching can change as a result of using particular technology. Ability to choose tools fit for the learning outcome. Maintaining module sites, Grading, Discussions, etc…
TCK	Knowledge about **how appropriate technology and content is related** (constraints and affordances to represent content. Subject matter can be **transformed** by the application of technology can. Example: Simulations changes the nature of learning.
TPACK	**Emergent knowledge** that goes beyond T, P and C Basis for **technology integration** in to teaching and learning practices

APPENDIX G: Focus group pre-discussion items

Knowledge Area (Mishra & Koehler, 2006)	"I have knowledge about", "I know how to"
"Technology knowledge (TK) is knowledge about standard technologies, such as books, chalk and blackboard, and more advanced technologies, such as the internet and digital video. This involves the skills required to operate particular technologies. In the case of digital technologies, this includes knowledge of operating systems and computer hardware, and the ability to use standard sets of software tools such as word processors, spreadsheets, browsers, and e-mail. TK includes knowledge of how to install and remove peripheral devices, install and remove software programs, and create and archive documents. Most standard technology workshops and tutorials tend to focus on the acquisition of such skills. Since technology is continually changing, the nature of TK needs to shift with time as well. For instance, many of the examples given above (operating systems, word processors, browsers, etc.) will surely change, and maybe even disappear, in the years to come. The ability to learn and adapt to new technologies (irrespective of what the specific technologies are) will still be important" (p. 1027).	***Knowledge of how to use 'core' default LMS (Sakai) tools'. A variety of tools are*** assigned once a module site is created for teaching and learning purposes. ☐ modify/personalise ☐ upload ☐ publish ☐ post ☐ customize ☐ track ☐ export ☐ update
"Pedagogical knowledge (PK) is deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses, among other things, overall educational purposes, values, and aims. This is a generic form of knowledge that is involved in all issues of student learning, classroom management, lesson plan development and implementation, and student evaluation. It includes knowledge about techniques or methods to be used in the classroom; the nature of the target audience; and strategies for evaluating student understanding. A teacher with deep pedagogical knowledge understands how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions toward learning. As such, pedagogical knowledge requires an understanding of cognitive, social, and developmental theories of learning and how they apply to students in their classroom" (p. 1026).	***Knowledge of "how to use" pedagogical principles*** ☐ pertaining to UNISA's open distance teaching and learning environment ***Knowledge of learning & developmental theories*** ☐ Behaviourism, cognitivism, constructivism, etc. ☐ How students learn ***Knowledge of teaching and learning methods*** ☐ processes ☐ practices ***Knowledge of learning environments*** ☐ study material ☐ learning activities ☐ authentic experiences ☐ various forms of interaction ☐ assessment (formative, summative)
"Content knowledge (CK) is knowledge about the actual subject matter that is to be learned or taught. The content to be covered in high school social studies or algebra is very different from the content to be covered in a graduate course on computer science or art history. Clearly, teachers must know and understand the subjects that they teach, including knowledge of central facts, concepts, theories, and procedures within a given field; knowledge of explanatory frameworks that organize and connect ideas; and knowledge of the rules of evidence and proof (Shulman, 1986). Teachers must also understand the nature of knowledge and inquiry in different fields. For example, how is a proof in mathematics different from a historical explanation or a literary interpretation? Teachers who do not have these understandings can misrepresent those subjects to their students (Ball & McDiarmid, 1990)" (p. 1026).	***Knowledge of the actual subject matter to be taught or learnt in a specific discipline*** ☐ curriculum content ☐ facts ☐ concepts ☐ theories ☐ techniques/procedures ☐ legitimate knowledge ☐ content for teaching ☐ central topics
Pedagogical Content Knowledge (PCK) The idea of pedagogical content knowledge is consistent with, and similar to, Shulman's idea of knowledge of pedagogy that is applicable to the teaching of specific content. This knowledge includes knowing what teaching approaches fit the content, and likewise, knowing how elements of the content can be arranged for better teaching. This knowledge is different from the knowledge of a disciplinary expert and also from the general pedagogical knowledge shared by teachers across disciplines. PCK is concerned with the representation and formulation of concepts, pedagogical techniques, knowledge of what makes concepts difficult or easy to learn, knowledge of students' prior knowledge, and theories of epistemology. It also involves knowledge of teaching strategies that incorporate appropriate conceptual representations in order to address learner difficulties and misconceptions and foster meaningful understanding. It also includes knowledge of what the students bring to the learning situation, knowledge that might be either facilitative or dysfunctional for the particular learning task at hand. This knowledge of students includes their strategies, prior conceptions (both ''naı¨ve'' and instructionally produced), misconceptions that they are likely to have about a particular domain, and potential misapplications of prior knowledge" (p. 1027).	***Knowledge of <u>content and students</u>*** ☐ misconceptions ☐ easy or difficult ☐ prior knowledge ***Knowledge of <u>content and teaching</u>*** ☐ represent content ☐ instructional strategies to fit content ☐ pace the content ☐ mastery of content ☐ interactive content ***Knowledge of <u>curriculum</u>*** ☐ learning materials, resources, tools ☐ central topics ☐ make connections between topics, concepts, disciplines

"Technological pedagogical knowledge (TPK) is knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies. This might include an understanding that a range of tools exists for a particular task, the ability to choose a tool based on its fitness, strategies for using the tool's affordances, and knowledge of pedagogical strategies and the ability to apply those strategies for use of technologies. This includes knowledge of tools for maintaining class records, attendance, and grading, and knowledge of generic technology-based ideas such as WebQuests, discussion boards, and chat rooms" (p. 1028).	***Knowledge of the relationship between LMS and pedagogy*** □ LMS operations, components and capabilities □ range of tools exists for a particular task □ ability to choose a tool based on its fitness □ strategies for using the tool's affordances ***Knowledge of the pedagogical uses of the LMS for teaching and learning*** □ the ability to apply pedagogical strategies when using the LMS □ knowing how teaching might change as the result of using LMS tools ***Knowledge of teaching and learning methods*** □ processes □ practices ***Knowledge of the LMS and students*** □ how learners interact with the LMS
"Technological content knowledge (TCK) is knowledge about the manner in which technology and content are reciprocally related. Although technology constrains the kinds of representations possible, newer technologies often afford newer and more varied representations and greater flexibility in navigating across these representations. Teachers need to know not just the subject matter they teach but also the manner in which the subject matter can be changed by the application of technology. For example, consider Geometer's Sketchpad as a tool for teaching geometry. It allows students to play with shapes and form, making it easier to construct standard geometry proofs. In this regard, the software program merely emulates what was done earlier when learning geometry. However, the computer program does more than that. By allowing students to ''play'' with geometrical constructions, it also changes the nature of learning geometry itself; proofs by construction are a form of representation in mathematics that was not available prior to this technology. Similar arguments can be made for a range of other software products" (p. 1028).	***Knowledge of the relationship between LMS and specific content*** □ how the LMS affords varied representations of content (what is possible) □ how the LMS offers flexibility in navigating across different representations □ how the LMS constrains some kinds of representations of content (what is not possible) □ how to integrate third party software (media, content and systems integration) in the LMS to represent different concepts □ How the subject matter can be changed by the application of the LMS □ changes the nature of learning (e.g. simulations, games)
"Technological Pedagogical Content Knowledge (TPACK) is an emergent form of knowledge that goes beyond all three components (content, pedagogy, and technology). This knowledge is different from knowledge of a disciplinary or technology expert and also from the general pedagogical knowledge shared by teachers across disciplines. TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones" (pgs 1028-1029).	***Knowledge of the relationship between LMS, pedagogy and content*** □ an evolving form of knowledge that goes beyond other forms of educator knowledge

APPENDIX H: Draft survey for expert review

INSTRUCTIONS: • Thank you for agreeing to serve as a reviewer for LMS-TPACK research. • You have been invited to serve as a reviewer because of your expertise in the research topic. • Rate how the relevance of each TPACK item by ticking on the three point scale • You are encouraged to make inputs or recommendations in the comments column regarding revisions or additional information that needs inclusion before the survey is despatched. • Also please alert the researcher to any potential inadequacies or ethical concerns. **TECHNOLOGY** is a broad concept and can mean a myriad of things. For the purpose of this study technology refers to the myUNISA institutional Learner Management System (LMS) that is used for the purposes of teaching and learning.		**Not necessary** **1**	**Useful, but not essential** **2**	**Essential** **3**	**Comments**
LMS-Knowledge (LMS-K) generally encompasses knowledge about LMS, i.e. knowing how to manipulate and apply a variety of LMS-based tools as well as the ability to troubleshoot technical problems as they arise. LMS-K is constantly changing and can shift as a result of on-going training and years' experience.					
1.1	I have the necessary skills and competence required to use the LMS				
1.2	I know how to solve and troubleshoot my own technical myUNISA problems				
1.3	I am able to independently tackle various LMS related issues such as downloading appropriate plug-ins, installing programmes, network connections, etc.…				
1.4	I am able to assist students with LMS related queries				
1.5	I frequently play around with various LMS tools				
1.6	I have knowledge of latest Sakai LMS developments				
1.7	I know a lot about different LMS tools				
1.8	Unaided I am able to learn a new LMS tool easily				
1.9	I make use of latest available myUNISA tools				
1.1	I can install a new programme on my own				
1.11	I can send an email with an attachment				
1.12	I can create a Word document, PowerPoint Presentation , Excel spread sheet				
1.13	I can search the internet for information				
1.14	I have sufficient opportunities to teach with different myUNISA tools				
1.15	I can set up various myUNISA tools such as Discussions, Blogs, Wikis, etc.…				
Content Knowledge (CK) includes knowledge of the curriculum, facts, concepts, theories, techniques; central topics as well as selecting content for teaching that meet the requirements and standards of accredited professional bodies and broader educational goals.					
2.1	I have sufficient knowledge about my content				
2.2	I know how to create materials that aligns to specific Higher Education scientific guidelines/requirements/standards				
2.3	I am able to decide on the scope of concepts taught within in my module				

2.4	I am able to plan the sequence of concepts taught within my module				
2.5	I know and understand key facts, concepts, theories and procedures within my module				
2.6	I know and understand the nature of knowledge and enquiry is different for my discipline				
2.7	What I teach drives my pedagogical goals and myUNISA tools used				
2.8	I can use a particular way of thinking when teaching my content				
2.9	I have various ways and strategies of developing my students understanding of my content				
Pedagogical Knowledge (PK) refers to a wide-range of strategies, practices and methods of teaching that facilitate student distant learning as it applies generally across different subject domains.					
3.1	I am able to determine particular strategies best suited to teach specific concepts				
3.2	I know how to use a variety of teaching strategies to relate various concepts to students				
3.3	I can adjust my teaching methodology based on student performance/feedback.				
3.4	I know how to assess student progress and performance				
3.5	I can assess student learning using multiple assessment strategies				
3.6	I can adapt my teaching based upon students prior knowledge				
3.7	I can adapt my teaching based-upon what students currently understand or do not understand (difficult concepts)				
3.8	I can adapt my teaching style to address individual differences				
3.9	I can use a wide range of teaching approaches to foster flexible, interactive, rich, inquiry-based, collaborative, etc.… teaching and learning environment				
3.1	I am familiar with common student understandings and misconceptions				
3.11	I know how to organize and maintain my module site				
3.12	I know how to scaffold learning by making available on-going support and motivation to students				
Pedagogical Content Knowledge (PCK) emphasises the blending of pedagogical and content knowledge. PCK includes knowledge of the students and their characteristics; the likely preconceptions and misconceptions students bring along to the learning situation as well as understanding the full range of materials for instruction or tools of the trade e.g. different texts, visual and audio tools.					
4.1	I can distinguish between correct and incorrect problem solving attempts by students				
4.2	I can anticipate likely student misconceptions within a particular topic.				
4.3	I can comfortably produce lesson plans with an appreciation for the topic				
4.4	I am able to assist students in recognizing connections between various concepts in my module(s)				
4.5	I know how to arrange and represent content for online delivery				
4.6	I know how to select appropriate teaching methods to guide student thinking when learning content online				
LMS-Pedagogical Knowledge (LMS-PK) refers to knowledge (content-free) about the tools and functions of the LMS and understanding how they might be used for instructional purposes.					
5.1	I know how to create an online environment which allows students to construct new knowledge and skills.				

5.2	I know how to implement different methods of teaching online				
5.3	I know how to moderate online interactivity among students				
5.4	I know how to encourage online interactivity among students				
5.5	I know how to choose myUNISA tools that enhance mixed teaching strategies				
5.6	I know how to choose myUNISA tools that enhance students' learning				
5.7	I think critically about how to use myUNISA tools in my module site				
5.8	I know how to adjust/adapt the myUNISA tools that I am learning about to different teaching activities				
LMS-Content Knowledge (LMS-CK) describes the knowledge associated with being a subject-specialist (free of pedagogical strategies) and understanding how the LMS can be used to teach and bolster the content and how the nature of the content can be transformed.					
6.1	I know how to deliver my module (fully/partially) online via myUNISA				
6.2	I am able to use myUNISA for various representations to demonstrate specific concepts (i.e. multimedia, visual demonstrations, simulations, etc.…)				
6.3	I know about different myUNISA tools that I can use to enhance understanding when doing content-specific tasks				
6.4	I use various technologies to deliver instruction (e.g., Video conferencing, Facebook, Twitter, etc.…).				
6.5	I know my use of myUNISA constrains varied representation of specific content				
6.6	Content knowledge can be transformed and represented fittingly by the application of myUNISA tools				
6.7	I use other software applications to more appropriately represent content knowledge				
LMS Technological Pedagogical Content Knowledge (LMS-TPACK) is described as the manner in which knowledge about LMS tools, their pedagogical affordances, pedagogy, content, students, and the ODL context are synthesized into an understanding of how to represent and formulate particular concepts and knowing how to use LMS to provide multiple alternative forms of representation, making it more accessible to students, knowledge of instructional strategies (i.e. scaffolding, chunking, pacing, etc.) and using the LMS in any one or combination of ways to teach content, knowledge of difficult or easy concepts and using LMS to provide remedial actions, and support students who encounter learning difficulties; including knowledge of students' prior knowledge and experiences; and using LMS to link to existing knowledge, context and the new knowledge to be learnt, making the associations explicit.					
7.1	I am able to use online student assessment to modify instruction				
7.2	I am able to use myUNISA and predict students' skill/understanding of a particular topic				
7.3	I am able to use myUNISA to create effective representations of content that depart from textbook knowledge				
7.4	I am able to use myUNISA to meet the overall demands of teaching my module online				
7.5	I teach lessons that appropriately combine science content, myUNISA and various teaching approaches				
7.6	I can select appropriate purpose led myUNISA tools for use on my module site that enhance what I teach, how I teach and what students learn.				
7.7	I can use strategies that combine content, myUNISA tools and teaching approaches that I learnt about in my coursework in my classroom.				
7.8	I can help fellow colleagues to coordinate their use of content, myUNISA tools and teaching approaches in my College/Department				
7.9	I am able to choose appropriate myUNISA tools that enhance the content				

Demographic Information

1.1 Gender
- ☐ Male
- ☐ Female

1.2 Nationality
- ☐ South African
- ☐ Foreign National State country of origin____________________

1.3 Highest Qualification achieved ______________

1.4 Major(s) _________________ _______________________

1.5 Area of Specialization

College of Agriculture & Environmental Sciences

School of Environmental Sciences
- ☐ Environmental Sciences
- ☐ Geography

School of Agriculture & Life Sciences
- ☐ Life & consumer Sciences
- ☐ Agriculture & Animal Health

College of Science Engineering & Technology

School of Science
- ☐ Mathematics
- ☐ Physics
- ☐ Chemistry
- ☐ Statistics

School of Engineering
- ☐ Civil & Chemical Engineering
- ☐ Electrical & Mining Engineering
- ☐ Mechanical & Industrial Engineering

School of Computing
- ☐ Centre for Software Engineering (CENSE)

1.6 ICT related qualification/short course(s) completed _____________________________

1.7 Teaching qualification/short course(s) completed ______________________________

1.8 Have you attended any of the following:
- ☐ DCLD Induction for new academic teaching staff
- ☐ Assessor training
- ☐ Moderator training
- ☐ A-Z of myUNISA tools
- ☐ myUNISA Forums series
- ☐ Virtual Learning Environment (VLE) training
- ☐ Mentor/mentee training
- ☐ IT software training (Word, Excel, PowerPoint, SPSS, Mendeley, Microsoft Outlook, etc.…)
- ☐ Other __________________ _____________________ _____________________

1.9 Number of years teaching experience
- ☐ 0 - 2 years
- ☐ – 5 years
- ☐ 6 – 10 years
- ☐ 20+ years

1.10 Age range
- ☐ >20
- ☐ 21 – 25 years
- ☐ 26 – 30 years
- ☐ 31 – 40 years
- ☐ 41 – 50 years
- ☐ <51 years

1.11 Frequency of use of myUNISA *on campus* for teaching /support students
- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Never

1.12 Frequency of use of myUNISA *off campus* for teaching /support students

- Daily
- Weekly
- Monthly
- Never

1.13 Other technologies/applications/social media employed for purposes of teaching and learning

- Video conferencing
- Mobile telephone
- Google Suite
- Mega
- Facebook
- WhatsApp
- Twitter
- Podcasts
- Vodcasts
- Other ________________________ __________________________ ________________________

APPENDIX I: myUNISA LMS-TPACK self-rating survey

UNISA university of south africa

myUnisa Self-rating Survey

Rate your myUnisa - Technological Pedagogical Content Knowledge (myUnisa-TPACK).

- Please answer all questions.
- For each item select your level of agreement or disagreement by clicking on the appropriate measure.
- Click Neither Agree nor Disagree if you are uncertain of or neutral about your response.
- By clicking **NEXT** you agree that you have read and accept to participate.

Please note **feedback** only provides a general indication of skill areas that might need to be developed. The assessment report serves as a mere reflection and will not be used for research purposes.

Exit and clear survey | Next

UNISA university of south africa

myUnisa Self-rating Survey

* **Technology is a broad concept that can mean a lot of different things. For the purpose of this survey, technology refers to the myUnisa Learner Management System.**

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to modify/personalise the default *Homepage*	○	○	○	○	○	○
I know how to upload *Official Study Material* (e.g. Tutorial Letters, Study Guides, previous exam papers)	○	○	○	○	○	○
I know how to upload *Prescribed Book Lists* (e.g. display prescribed books, recommended readings, e-reserves)	○	○	○	○	○	○
I know how to publish discussions using the *Discussion Forums tool* (e.g. add module discussion activities, create topics to discuss assignment/ exam queries)	○	○	○	○	○	○
I know how to post information using the *Announcements tool* (e.g. post messages on module site that can also be mailed to the class)	○	○	○	○	○	○
I know how to customize the *Schedule tool* (e.g. for posting and viewing deadlines, events related to a course)	○	○	○	○	○	○
I know how to upload *Additional Resources* (e.g. class notes, multimedia files)	○	○	○	○	○	○
I know how to track assignments using the *Assignments tool* (e.g. assignment statistics, MCQ marking reports, assignment status reports, marking statistics)	○	○	○	○	○	○
I know how to export statistical reports using the *Statistics tool* (e.g. user visits, tool and resource activity)	○	○	○	○	○	○
I know how to update module site settings using the *Site Info tool*	○	○	○	○	○	○

Exit and clear survey | Previous | Next

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to *design study material* for distance learning	○	○	○	○	○	○
I know how to *align* learning *outcomes, instruction* and *assessment*	○	○	○	○	○	○
I know how to *draw from* a range of *learning theories* (e.g. behaviourism, constructivism, cognitivism, etc.)	○	○	○	○	○	○
I know how to *integrate* a mix of student *support strategies* (e.g. courseware, tutorials, feedback, practical work, sms, email)	○	○	○	○	○	○
I know how to *use* different *assessment strategies* (e.g. formative, summative assessments)	○	○	○	○	○	○
I know how to *facilitate* varied forms of *interaction* (e.g. between student-and-student, student-and-lecturer, student-and-tutor, student-and-content)	○	○	○	○	○	○
I know how to *sequence* learning *activities* (e.g. from simple to complex)	○	○	○	○	○	○
I know how to *link* instructional activities to *authentic experiences* (e.g. everyday real-life experiences)	○	○	○	○	○	○

Exit and clear survey   Previous   Next

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I have knowledge of the *curriculum content* in my discipline (e.g. set of courses/modules that make up a full programme)	○	○	○	○	○	○
I have knowledge of *key facts* in my discipline	○	○	○	○	○	○
I have knowledge of *basic concepts* in my discipline (e.g. language, terminology, labels)	○	○	○	○	○	○
I have knowledge of *fundamental theories* that underpin my discipline (e.g. philosophies, rules, models, principles)	○	○	○	○	○	○
I have knowledge of various *techniques/procedures* in my discipline (e.g. methods, ways of doing things)	○	○	○	○	○	○
I have knowledge of what constitutes *legitimate knowledge* in my discipline (e.g. distinguish between correct and incorrect knowledge; fact and opinion)	○	○	○	○	○	○
I have knowledge of how to select *content for teaching* that meet requirements of accredited professional/educational standards/bodies in my discipline	○	○	○	○	○	○
I have knowledge of *central topics* taught in my discipline	○	○	○	○	○	○

Exit and clear survey   Previous   Next

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
Without using myUnisa tools, I know how to *address misconceptions* students might have *about the content* (e.g. misunderstandings, mistaken beliefs)	○	○	○	○	○	○
Without using myUnisa tools, I know how to *select instructional strategies* that *fit the content* (e.g. group work, activity-based learning, experiential learning)	○	○	○	○	○	○
Without using myUnisa tools, I know how to *pace learning activities* so students are able to *master the content* (e.g. timed readings, timed assessments)	○	○	○	○	○	○
Without using myUnisa tools, I know how to *address topics/concepts* students are likely to find *easy or difficult* about the content	○	○	○	○	○	○
Without using myUnisa tools, I know how to *design interactive content* for students to input or respond to (e.g. students input or respond to self-assessments, quizzes to generate a result)	○	○	○	○	○	○
Without using myUnisa tools, I know how to *link* students *prior knowledge* to the content (e.g. use introductory entry-level learning activities, set baseline assessments)	○	○	○	○	○	○
Without using myUnisa tools, I know how to *represent the content* in multiple ways (e.g. useful analogies, illustrations, examples, explanations)	○	○	○	○	○	○
Without using myUnisa tools, I know how to *make connections* between various *concepts/topics/related modules*	○	○	○	○	○	○

Exit and clear survey | Previous | Next

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to use myUnisa to *orientate* students online (e.g. clarify outcomes, instruction and assessment criteria in module site)	○	○	○	○	○	○
I know how to use myUnisa to *scaffold* learning online (e.g. guide students' learning from simple to more complex tasks/concepts)	○	○	○	○	○	○
I know how to use myUnisa to *create* assessments online (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	○	○	○	○	○	○
I know how to use myUnisa to *design* multiple forms of feedback online (e.g. electronic, sms, Announcements, emails, comments in the grade book)	○	○	○	○	○	○
I know how to use myUnisa for varied forms of *representation* online (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	○	○	○	○	○	○
I know how to use myUnisa to *monitor* student learning online (e.g. assignment submissions and marks, discussions, blogs)	○	○	○	○	○	○
I know how to use myUnisa to *provide* for diverse digital capabilities of students online (e.g. module site interface functional for novice users, disabled users, sensitive to language)	○	○	○	○	○	○
I know how to use myUnisa to *form* part of a blended mode (e.g. combine print, online, face to face, other media)	○	○	○	○	○	○

Exit and clear survey | Previous | Next

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to use myUnisa to *direct* students to web-based content (e.g. access through RSS Feeds to online publishers, libraries)	○	○	○	○	○	○
I know how to use myUnisa to *integrate* third party software/tools to communicate concepts (e.g. AutoCAD, GIS, DrGeo, Math Blaster, KGeography, Bookkeeper)	○	○	○	○	○	○
I know how to use myUnisa to *demonstrate* unobservable, obscure facts/concepts/principles invisible to the eye (e.g. using illustrations, simulations, games, mind mapping)	○	○	○	○	○	○
I know how to use myUnisa to *transform* the content (e.g. running an online video or simulation is different from reading printed text)	○	○	○	○	○	○
I know how to use myUnisa to *offer* flexible access across multiple representations (e.g. link text, graph, diagrams, videos, formulas)	○	○	○	○	○	○
I know how to use myUnisa to *chunk* the content (e.g. split or break content into several smaller segments)	○	○	○	○	○	○
I know how to use myUnisa to *generate* online discussions that highlight key content (e.g. draw attention to central topics/patterns/relationships using the Discussion forums tool)	○	○	○	○	○	○
I know how to use myUnisa to *afford* students opportunities to actively engage with the content (e.g. foster student-centred learning)	○	○	○	○	○	○

Exit and clear survey | Previous | Next

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to *combine* teaching strategies with myUnisa tools to transform the content (e.g. problem-based learning, experiential learning, activity-based learning)	○	○	○	○	○	○
I know how to *clarify* difficult concepts usingby selecting myUnisa tools that afford different forms of *representation* (e.g. multimedia, visual, auditory illustrations, presentations, simulations)	○	○	○	○	○	○
I know how to *integrate* myUnisa tools and web-based content to support blended learning (e.g. a combine print, other media)	○	○	○	○	○	○
I know how to *create* multiple assessments online using myUnisa tools that allow students to *master the content* (e.g. closed/open ended questions, timed assessments, matching questions, question pools)	○	○	○	○	○	○
I know how to *guide* students to web-based content by making use of myUnisa tools that provide opportunities for flexible learning (e.g. students can learn and access materials at own time, place and space)	○	○	○	○	○	○
I know how to *integrate* myUnisa tools that allow students' to participate in online discussions related to content (e.g. discussion forums, blogs, wikis)	○	○	○	○	○	○
I know how to *use* a team approach to integrate pedagogy, content and myUnisa tools in the design of the module (e.g. complete certificate of due diligence)	○	○	○	○	○	○
I know how to *combine* content and myUnisa tools to provide students opportunities to interactively engage as part of their learning (e.g. students input/respond to online activities, assessments, discussions)	○	○	○	○	○	○

Exit and clear survey | Previous | Next

UNISA myUnisa Self-rating Survey

* Please complete the demographic information, it will remain confidential and will only be used for

1.1 Age range

Choose one of the following answers

- ○ 20-29 years
- ○ 30-39 years
- ○ 40-49 years
- ○ 50-59 years
- ○ 60+ years

* **1.2 Gender**

Choose one of the following answers

- ○ Male
- ○ Female

* **1.3 Population group**

Choose one of the following answers

- ○ Black (African)
- ○ Indian
- ○ Coloured
- ○ White
- ○ Other ______

* **1.4 Nationality**

Choose one of the following answers

- ○ South African
- ○ Foreign National

* **1.5 Highest qualification attained**

Choose one of the following answers

- ○ First Degree
- ○ Honours
- ○ Masters
- ○ PhD

* **1.7 Employed in the**

Choose one of the following answers

- ○ College of Accounting Sciences
- ○ College of Agriculture & Environmental Sciences
- ○ College of Economic & Management Sciences
- ○ College of Education
- ○ College of Human Sciences
- ○ College of Law
- ○ College of Science, Engineering & Technology

* **1.7 School employed in**

Choose one of the following answers

- ○ Accountancy
- ○ Applied Accountancy
- ○ Agriculture & Life Sciences
- ○ Environmental Sciences
- ○ Economic Sciences
- ○ Management Sciences
- ○ Educational Studies
- ○ Teacher Education
- ○ Arts
- ○ Humanities
- ○ Social Sciences
- ○ Law
- ○ Criminal Justice

- Science
- Engineering
- Computing
- Other ____________

* 1.9 Completed any ICT related qualification/course

Choose one of the following answers

- Yes
- No

* 1.10 Completed any Teaching qualification/course

Choose one of the following answers

- Yes
- No

* 1.11 Attended myUnisa training

Choose one of the following answers

- Yes
- No

* 1.12 Number of years distance education teaching experience

Choose one of the following answers

- 0-5 years
- 6-10 years
- 11-14 years
- 15-20 years
- 21-24 years
- 25-30 years
- 31+ years

* 1.13 NQF level(s) taught

Check any that apply

- ☐ NQF level 5
- ☐ NQF level 6
- ☐ NQF level 7
- ☐ Post graduates

* 1.14 Frequency of use of technologies/applications/social media for teaching and supporting students

	Daily	Weekly	Monthly	Never
myUnisa on campus	○	○	○	○
myUnisa off campus	○	○	○	○
Video conferencing	○	○	○	○
Mobile telephone	○	○	○	○
Facebook	○	○	○	○
WhatsApp	○	○	○	○
Twitter	○	○	○	○
Podcasts	○	○	○	○
Vodcasts	○	○	○	○

1.15 Other technologies/applications/social media you currently use for teaching and supporting students

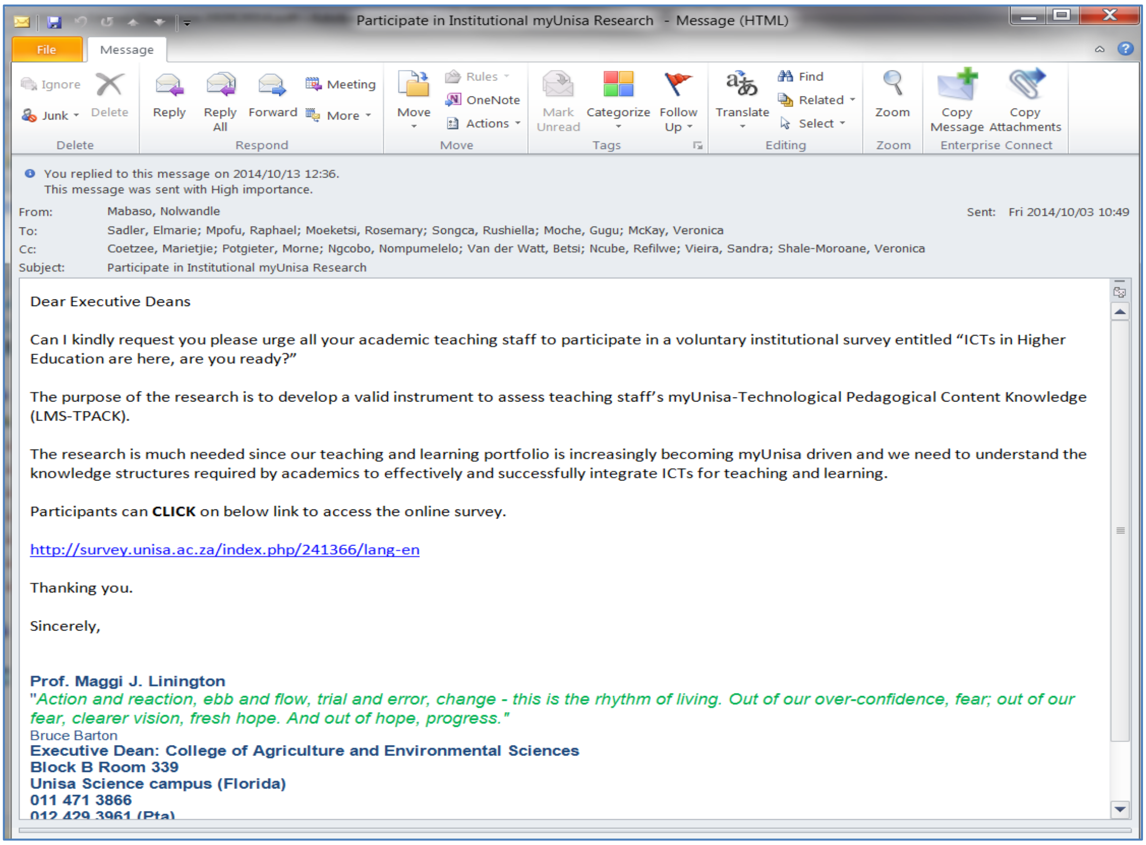
Exit and clear survey | ‹Previous | Submit

Your assessment

- You have competent myUnisa knowledge/capabilities.
- You have competent pedagogical knowledge/capabilities.
- You have competent content knowledge/capabilities.
- You have competent pedagogical content knowledge/capabilities.
- You have competent myUnisa pedagogical knowledge/capabilities.
- You have competent myUnisa content knowledge/capabilities.
- You have competent myUnisa pedagogical content knowledge/capabilities.

Thank you for your participation.

APPENDIX J: Reminder follow-up email



Participate in Institutional myUnisa Research - Message (HTML)

You replied to this message on 2014/10/13 12:36.
This message was sent with High importance.

From: Mabaso, Nolwandle
Sent: Fri 2014/10/03 10:49
To: Sadler, Elmarie; Mpofu, Raphael; Moeketsi, Rosemary; Songca, Rushiella; Moche, Gugu; McKay, Veronica
Cc: Coetzee, Marietjie; Potgieter, Morne; Ngcobo, Nompumelelo; Van der Watt, Betsi; Ncube, Refilwe; Vieira, Sandra; Shale-Moroane, Veronica
Subject: Participate in Institutional myUnisa Research

Dear Executive Deans

Can I kindly request you please urge all your academic teaching staff to participate in a voluntary institutional survey entitled “ICTs in Higher Education are here, are you ready?”

The purpose of the research is to develop a valid instrument to assess teaching staff’s myUnisa-Technological Pedagogical Content Knowledge (LMS-TPACK).

The research is much needed since our teaching and learning portfolio is increasingly becoming myUnisa driven and we need to understand the knowledge structures required by academics to effectively and successfully integrate ICTs for teaching and learning.

Participants can **CLICK** on below link to access the online survey.

http://survey.unisa.ac.za/index.php/241366/lang-en

Thanking you.

Sincerely,

Prof. Maggi J. Linington
"Action and reaction, ebb and flow, trial and error, change - this is the rhythm of living. Out of our over-confidence, fear; out of our fear, clearer vision, fresh hope. And out of hope, progress."
Bruce Barton
Executive Dean: College of Agriculture and Environmental Sciences
Block B Room 339
Unisa Science campus (Florida)
011 471 3866
012 429 3961 (Pta)

APPENDIX K: Finalised LMS-TPACK instrument

myUnisa Self-rating Survey

Rate your myUnisa - Technological Pedagogical Content Knowledge (myUnisa-TPACK).

- Please answer all questions.
- For each item select your level of agreement or disagreement by clicking on the appropriate measure.
- Click Neither Agree nor Disagree if you are uncertain of or neutral about your response.
- By clicking **NEXT** you agree that you have read and accept to participate.

Please note **feedback** only provides a general indication of skill areas that might need to be developed. The assessment report serves as a mere reflection and will not be used for research purposes.

Exit and clear survey | Next

myUnisa Self-rating Survey

Technology is a broad concept that can mean a lot of different things. For the purpose of this survey, technology refers to the myUnisa Learner Management System.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to modify/personalise the default *Homepage*	○	○	○	○	○	○
I know how to upload *Official Study Material* (e.g. Tutorial Letters, Study Guides, previous exam papers)	○	○	○	○	○	○
I know how to upload *Prescribed Book Lists* (e.g. display prescribed books, recommended readings, e-reserves)	○	○	○	○	○	○
I know how to publish discussions using the *Discussion Forums tool* (e.g. add module discussion activities, create topics to discuss assignment/ exam queries)	○	○	○	○	○	○
I know how to post information using the *Announcements tool* (e.g. post messages on module site that can also be mailed to the class)	○	○	○	○	○	○
I know how to customize the *Schedule tool* (e.g. for posting and viewing deadlines, events related to a course)	○	○	○	○	○	○
I know how to upload *Additional Resources* (e.g. class notes, multimedia files)	○	○	○	○	○	○
I know how to track assignments using the *Assignments tool* (e.g. assignment statistics, MCQ marking reports, assignment status reports, marking statistics)	○	○	○	○	○	○
I know how to export statistical reports using the *Statistics tool* (e.g. user visits, tool and resource activity)	○	○	○	○	○	○
I know how to update module site settings using the *Site Info tool*	○	○	○	○	○	○

Exit and clear survey | Previous | Next

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to *design study material* for distance learning	○	○	○	○	○	○
I know how to *align* learning *outcomes, instruction* and *assessment*	○	○	○	○	○	○
I know how to *draw from* a range of *learning theories* (e.g. behaviourism, constructivism, cognitivism, etc.)	○	○	○	○	○	○
I know how to *integrate* a mix of student *support strategies* (e.g. courseware, tutorials, feedback, practical work, sms, email)	○	○	○	○	○	○
I know how to *use* different *assessment strategies* (e.g. formative, summative assessments)	○	○	○	○	○	○
I know how to *facilitate* varied forms of *interaction* (e.g. between student-and-student, student-and-lecturer, student-and-tutor, student-and-content)	○	○	○	○	○	○
I know how to *sequence* learning *activities* (e.g. from simple to complex)	○	○	○	○	○	○
I know how to *link* instructional activities to *authentic experiences* (e.g. everyday real-life experiences)	○	○	○	○	○	○

Exit and clear survey | Previous | Next

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I have knowledge of the *curriculum content* in my discipline (e.g. set of courses/modules that make up a full programme)	○	○	○	○	○	○
I have knowledge of *key facts* in my discipline	○	○	○	○	○	○
I have knowledge of *basic concepts* in my discipline (e.g. language, terminology, labels)	○	○	○	○	○	○
I have knowledge of *fundamental theories* that underpin my discipline (e.g. philosophies, rules, models, principles)	○	○	○	○	○	○
I have knowledge of various *techniques/procedures* in my discipline (e.g. methods, ways of doing things)	○	○	○	○	○	○
I have knowledge of what constitutes *legitimate knowledge* in my discipline (e.g. distinguish between correct and incorrect knowledge; fact and opinion)	○	○	○	○	○	○
I have knowledge of how to select *content for teaching* that meet requirements of accredited professional/educational standards/bodies in my discipline	○	○	○	○	○	○
I have knowledge of *central topics* taught in my discipline	○	○	○	○	○	○

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UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
Without using myUnisa tools, I know how to *address misconceptions* students might have *about the content* (e.g. misunderstandings, mistaken beliefs)						
Without using myUnisa tools, I know how to *select instructional strategies* that *fit the content* (e.g. group work, activity-based learning, experiential learning)						
Without using myUnisa tools, I know how to *pace learning activities* so students are able to *master the content* (e.g. timed readings, timed assessments)						
Without using myUnisa tools, I know how to *address topics/concepts* students are likely to find *easy or difficult* about the content						
Without using myUnisa tools, I know how to *design interactive content* for students to input or respond to (e.g. students input or respond to self-assessments, quizzes to generate a result)						
Without using myUnisa tools, I know how to *link* students *prior knowledge* to the content (e.g. use introductory entry-level learning activities, set baseline assessments)						
Without using myUnisa tools, I know how to *represent the content* in multiple ways (e.g. useful analogies, illustrations, examples, explanations)						
Without using myUnisa tools, I know how to *make connections* between various *concepts/topics/related modules*						

Exit and clear survey ‹Previous Next›

Exit and clear survey ‹Previous Next›

UNISA university of south africa

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to use myUnisa to *orientate* students online (e.g. clarify outcomes, instruction and assessment criteria in module site)						
I know how to use myUnisa to *scaffold* learning online (e.g. guide students' learning from simple to more complex tasks/concepts)						
I know how to use myUnisa to *create* assessments online (e.g. closed/open ended questions, timed assessments, matching questions, question pools)						
I know how to use myUnisa to *design* multiple forms of feedback online (e.g. electronic, sms, Announcements, emails, comments in the grade book)						
I know how to use myUnisa for varied forms of *representation* online (e.g. multimedia, visual, auditory illustrations, presentations, simulations)						
I know how to use myUnisa to *monitor* student learning online (e.g. assignment submissions and marks, discussions, blogs)						
I know how to use myUnisa to *provide* for diverse digital capabilities of students online (e.g. module site interface functional for novice users, disabled users, sensitive to language)						

Exit and clear survey ‹Previous Next›

UNISA

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to use myUnisa to *direct* students to web-based content (e.g. access through RSS Feeds to online publishers, libraries)						
I know how to use myUnisa to *integrate* third party software/tools to communicate concepts (e.g. AutoCAD, GIS, DrGeo, Math Blaster, KGeography, Bookkeeper)						
I know how to use myUnisa to *demonstrate* unobservable, obscure facts/concepts/principles invisible to the eye (e.g. using illustrations, simulations, games, mind mapping)						
I know how to use myUnisa to *transform* the content (e.g. running an online video or simulation is different from reading printed text)						
I know how to use myUnisa to *offer* flexible access across multiple representations (e.g. link text, graph, diagrams, videos, formulas)						
I know how to use myUnisa to *chunk* the content (e.g. split or break content into several smaller segments)						
I know how to use myUnisa to *afford* students opportunities to actively engage with the content (e.g. foster student-centred learning)						

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UNISA

myUnisa Self-rating Survey

*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not applicable
I know how to *combine* teaching strategies with myUnisa tools to transform the content (e.g. problem-based learning, experiential learning, activity-based learning)						
I know how to *clarify* difficult concepts usingby selecting myUnisa tools that afford different forms of *representation* (e.g. multimedia, visual, auditory illustrations, presentations, simulations)						
I know how to *integrate* myUnisa tools and web-based content to support blended learning (e.g. a combine print, other media)						
I know how to *guide* students to web-based content by making use of myUnisa tools that provide opportunities for flexible learning (e.g. students can learn and access materials at own time, place and space)						
I know how to *integrate* myUnisa tools that allow students' to participate in online discussions related to content (e.g. discussion forums, blogs, wikis)						
I know how to *use* a team approach to integrate pedagogy, content and myUnisa tools in the design of the module (e.g. complete certificate of due diligence)						
I know how to *combine* content and myUnisa tools to provide students opportunities to interactively engage as part of their learning (e.g. students input/respond to online activities, assessments, discussions)						

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UNISA

myUnisa Self-rating Survey

* Please complete the demographic information, it will remain confidential and will only be used for

1.1 Age range

Choose one of the following answers

- ○ 20-29 years
- ○ 30-39 years
- ○ 40-49 years
- ○ 50-59 years
- ○ 60+ years

* 1.2 Gender

Choose one of the following answers

- ○ Male
- ○ Female

* 1.3 Population group

Choose one of the following answers

- ○ Black (African)
- ○ Indian
- ○ Coloured
- ○ White
- ○ Other ____________

* 1.4 Nationality

Choose one of the following answers

- ○ South African
- ○ Foreign National

* 1.5 Highest qualification attained

Choose one of the following answers

- ○ First Degree
- ○ Honours
- ○ Masters
- ○ PhD

* 1.7 Employed in the

Choose one of the following answers

- ○ College of Accounting Sciences
- ○ College of Agriculture & Environmental Sciences
- ○ College of Economic & Management Sciences
- ○ College of Education
- ○ College of Human Sciences
- ○ College of Law
- ○ College of Science, Engineering & Technology

* 1.7 School employed in

Choose one of the following answers

- ○ Accountancy
- ○ Applied Accountancy
- ○ Agriculture & Life Sciences
- ○ Environmental Sciences
- ○ Economic Sciences
- ○ Management Sciences
- ○ Educational Studies
- ○ Teacher Education
- ○ Arts
- ○ Humanities
- ○ Social Sciences
- ○ Law
- ○ Criminal Justice

- Science
- Engineering
- Computing
- Other

* 1.9 Completed any ICT related qualification/course

Choose one of the following answers

- Yes
- No

* 1.10 Completed any Teaching qualification/course

Choose one of the following answers

- Yes
- No

* 1.11 Attended myUnisa training

Choose one of the following answers

- Yes
- No

* 1.12 Number of years distance education teaching experience

Choose one of the following answers

- 0-5 years
- 6-10 years
- 11-14 years
- 15-20 years
- 21-24 years
- 25-30 years
- 31+ years

* 1.13 NQF level(s) taught

Check any that apply

- NQF level 5
- NQF level 6
- NQF level 7
- Post graduates

* 1.14 Frequency of use of technologies/applications/social media for teaching and supporting students

	Daily	Weekly	Monthly	Never
myUnisa on campus	○	○	○	○
myUnisa off campus	○	○	○	○
Video conferencing	○	○	○	○
Mobile telephone	○	○	○	○
Facebook	○	○	○	○
WhatsApp	○	○	○	○
Twitter	○	○	○	○
Podcasts	○	○	○	○
Vodcasts	○	○	○	○

1.15 Other technologies/applications/social media you currently use for teaching and supporting students

Exit and clear survey | ‹Previous | Submit

Your assessment

- You have competent myUnisa knowledge/capabilities.
- You have competent pedagogical knowledge/capabilities.
- You have competent content knowledge/capabilities.
- You have competent pedagogical content knowledge/capabilities.
- You have competent myUnisa pedagogical knowledge/capabilities.
- You have competent myUnisa content knowledge/capabilities.
- You have competent myUnisa pedagogical content knowledge/capabilities.

Thank you for your participation.