

Integrating Information and Communications Technology (ICT) into teaching and learning: The case of Mathematics, Science and Technology Education in one Higher Education Institution

By

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March 2014

## CERTIFICATE OF ORIGINALITY

I declare that this thesis is my original work. To the best of my knowledge, this study is not a reproduction of previously published or unpublished research or materials accepted for the award of any academic qualifications, except where due acknowledgement has been made in the text.



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## ABSTRACT

This study explores the integration of Information and Communication Technologies (ICT) into teaching and learning within one Higher Education institution. The main question driving the study was: *How is ICT integrated in the teaching and learning of mathematics, science and technology education (MSTE) in a Bachelor of Education programme?*

This is a case study of lecturers and students in Mathematics, Science and Technology Education. It makes use of questionnaires, interviews, field notes and document analyses to collect data. MSTE lecturers and students were assumed to be well versed in ICT usage and, therefore, well placed to assess its integration into teaching and learning.

There were five main findings: First, that Mathematics, Science and Technology Education lecturers showed some ambivalence in their ontological and epistemological orientation to using ICT. Some leaned towards the *instruction paradigm* and used ICT as a tool for the transmission of knowledge; others leaned towards the *learning paradigm*, showing an awareness of the need to elicit discovery through ICT. Secondly, that lecturers' understanding of ICT integration was oriented towards teaching and learning *from* technologies rather than *with* technologies. Thirdly, that processes of 'pedagogical evolution' were taking place, in terms of which there was a gradual but perceptible shift in the teaching and learning practice of both students and lecturers. Fourthly, there was no evidence to show that lecturers used ICT to promote innovative and creative teaching; in fact, students appeared to be more creative in using ICT resources, than lecturers. Fifthly, and finally, lecturers did not assign ICT-based tasks that promote conceptual understanding. They assigned tasks that asked students to extract and reproduce information from computers, without demonstrating understanding. When used in this way, ICT can, in fact, be de-skilling.

From these findings, it can be concluded that ICT integration cannot be understood without exploring the ontological and epistemological orientations, as well as the theoretical orientations, at play in the teaching and learning situation. It is on the

basis of these that *people*, that is, lecturers and students, make use of, ICTs to achieve desired goals. It is therefore recommended that, for the improvement of integration, there should be a greater emphasis on developing and sharing pedagogical expertise concerning ICT use in teaching and learning. It is recommended that a country-wide research survey should be undertaken, based on probability sampling and focussing on pedagogical issues in ICT integration in teaching and learning.

**Key Words:** Information and Communication Technologies; integration; ontology; epistemology; pedagogy

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## **DEDICATION**

My sincere thanks go to the Lord Almighty, for the strength and sustaining me through this research study.

### **Dedication**

I dedicate this thesis to my wife, Babalwa Zelpha Addam and my two boys Bill Hlomla Addam and Brian Sihle Addam.

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## LIST OF ACRONYMS AND ABBREVIATIONS

Becta:	British Education Communication and Technology Agency
CAL:	Computer Assisted Learning
CAI:	Computer Assisted Instruction
DACST:	Department of Art, Culture, Science and Technology
DMSTE:	Department of Mathematics, Science and Technology Education
DoE:	Department of Education
HE:	Higher Education
HEIs:	Higher Education Institutions
ICT:	Information and Communication Technology
ICTs:	Information and Communication Technologies
IT:	Information Technology
ITE:	Initial Teacher Education
LMS	Learning Management System
IWB:	Interactive Whiteboard
MKO:	More Knowledgeable Other
MSTE:	Mathematics, Science and Technology Education
UNESCO	United Nations Educational, Scientific and Cultural Organisation
ZDP:	Zone of Proximal Development

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## CHAPTER 1

### INTRODUCTION AND BACKGROUND

#### 1. INTRODUCTION

The 21<sup>st</sup> century is characterised as being a knowledgeable age, prompting many educational institutions, particularly the tertiary system, to consider capacity building, skills development and knowledge construction as a requisite in preparing students for the digital environment. Thus, the introduction of new technologies into mainstream university education is expected to penetrate and transform teaching and learning across the curriculum (Hennessy, Ruthven & Brindley, 2013) including mathematics, science and technology education.

This study explores how students and lecturers of mathematics, science and technology education infuse Information and Communications Technologies (ICTs) into classroom practice.

This chapter describes the educational context and positioning of the study through elaborative relations with other works, both locally and internationally. Next, the researcher explicates the rationale for ICTs in education, and its pedagogy and technology in a tertiary education context. This is followed by the problem statement, research question, research paradigm, a brief discussion of the research approach espousing the significance of the study, and followed by the objectives of the study. Finally, the researcher catalogues some key concepts used in the study, finally presenting a brief summary of the chapters.

#### 1.1 BACKGROUND AND CONTEXT

Today, we live in a technology and media-driven environment, marked by access to an abundance of information, technology tools and resources that have penetrated every area of modern society and revolutionised every aspect of our social and cultural lives, including education (Partnership for 21<sup>st</sup> Century Skills, 2011). The constantly changing educational landscape has seen a growing popularity of ICTs in institutions of higher learning. This has caused a paradigm shift in education, which now envisages a new type of teaching and learning culture that demands ICT

integration with pedagogy in teacher education programmes. However, the planning and integration of ICT in education is becoming more complex due to rapid changes in technology tools (Department of Education [DoE], 2005; Scrimshaw, 2004). In order to keep up with the demands of the present educational environment, it is necessary to ensure that successful and sustainable ICT integration takes place in tertiary institutions, especially in Initial Teacher Education (ITE), enabling teacher trainers and student teachers to make use of technology in their professional practice.

The discussion that follows gives a brief account of the evolving nature of ICT.

### **1.1.1 ICT evolution: Global perspectives**

The term ICT encompasses the range of hardware, such as desktop and portable computers, projection technology, digital equipment and data logging devices; software applications such as generic software and multimedia resources; and information systems such as intranet and internet (these were available at the time of the research). In essence, the term includes the use of digital technology by students and lecturers to carry out existing activities with respect to their pedagogical orientation, ontological and epistemological assumptions for innovative and creative teaching and learning, as well as for developing conceptual understanding.

ICT, in its conceptual stage, was referred to as Information Technology (IT), which Darnton and Giacoletto in Sansanwal (2009) defined as the systematic study of artefacts that can be used as a description of facts, in order to provide meaning or support for decision making. Furthermore, ICTs are artefacts that can be used for the organisation, processing, communication and application of information. However, Sansanwal (2000) defined IT as the use of hardware and software for efficient management of information such as storage, retrieval, processing, communication, diffusion and sharing of information for social, economic and cultural advancement. Information technology then leads to the development of Websites, and provides facilities for chats, e-mail, and surfing. However, IT was limited to a textual mode of transmission of information, though not only in the textual forms such as audio, video or any other media needed to be transmitted to the users. Thus, the emergence of ICT expands IT beyond the textual, to new inclusions such as e-learning, e-

Education, e-journal, and third generation mobile resources (Sansanwal 2000) and brings richer materials to the classroom for twenty-first century learning.

### **1.1.2 ICT and Education**

Education has largely contributed to an increase in the development of knowledge, enabling the environment to accept innovation and to build the human capacity required for integration into the 21<sup>st</sup> century global work environment. The role of ICT to support this developmental agenda, including the knowledge creation process, has been recognised by all stake holders in education (Jonassen, Howland, Marra & Crismond, 2008). Similarly, global reforms in education and challenging ICT demands have caused a remarkable shift in the structure of teaching and learning towards conceptual understanding of principles, concepts and processes (Jonassen, et al., 2008).

Educational transformation in teaching and learning is ever changing (Theroux, 2004; Day & Sachs, 2004), to the extent that technology has migrated deep into the educational sphere. This makes it a necessary resource in the teaching and learning environment. However, the changing face of technology has become so rapid in recent years, that planning and integration of ICT in education has become more complex, though interesting, as new ICTs develop (Jimoyiannis & Komis, 2007; Demiraslan & Usluel, 2008) and must be infused into the educational space for improved teaching and learning. It is therefore necessary to keep up with these changes, which as demanded in the 21<sup>st</sup> century, by ensuring that effective and sustainable ICT integration is upheld in initial teacher education, to enable students and lecturers to take advantage of the vast amounts of information, communication and collaboration provided to become experts in their fields, and to meet the demands of educational challenges (British Education Communications and Technology Agency [Becta], 2008).

Rastogi and Malhotra, (2013) among other researchers, show that ICTs provide a wide range of powerful tools that can help meet some of these challenges. For instance, they can assist in transforming the teacher-centred, or the transmission, model and text-bound teaching and learning, into technology- enriched contemporary dimensions of student-focused and interactive knowledge environments. ICT in contemporary education settings, not only facilitates delivery of

content, but also the learning process itself, as well as promoting international collaboration and networking in education and professional development.

It is important to understand that ICTs are more than hardware. They consist also of designs and the environments that engage students' cognitive learning strategies and critical thinking skills. This can be achieved if lecturers integrate technology and understand technology-as-partner, and not technology-as-teacher in the teaching and learning process, and acknowledge it as conceptually and intellectually engaging (Jonassen, Howland, Marra & Crismond, 2010) so that it supports meaningful learning, fosters meaning making, and accepts the important role of pedagogy in the integration process.

### **1.1.3 ICT and Pedagogy**

Pedagogy is concerned with the various forms of interaction between three agents, namely: lecturer, students and the knowledge domain, thereby comprising a triangle (Czerniewicz & Brown, 2005). Further, pedagogy is also about process, content and context (Czerniewicz & Brown, 2005). Therefore discussing ICTs and pedagogy requires inter-relationship between teaching slants and mechanisms, learning strategies and experiences, including the nature and structure of the content and the knowledge being created and constructed (Loveless, Devoogd & Bohlin, cited in Czerniewicz & Brown, 2005). Teaching and learning interactions and activities are likely to be linked to the integration of the appropriate technology tool, and supported by pedagogy which describes the framework for learning interactions linked to purpose.

McCormick and Scrimshaw (2001), described three levels of ICT pedagogy integration: Firstly; the use of ICTs to make existing practice more efficient and effective. In this case, ICT is infused into lecturers' established pedagogy. The second level is where it is extended in some new ways, implying that lecturers and students have to alter their existing pedagogy to accommodate and function in the ICT sphere. The third level involves a transformed pedagogy to operate within the domain of contemporary learning themes. It is important to emphasise that the operationalization of ICT in teaching and learning depends on the lecturers' and students' levels of integration.

Integration of ICT pedagogy in curriculum delivery purports to re-conceptualise the use of productivity tools to support the teaching and learning experience in a contemporary spectrum. In light of this, one can conveniently say that with aligned pedagogy, ICT tools should provide the capacity to communicate in ways that do not exist in the conventional classroom, including many-to-many interactions concurrently, which are essential in breaking the dominance of transmissionalism in the classroom-based discourse structure. However, the level of ICT pedagogy integration determines the effective use of productivity tools for such interactions.

Can these tools provide a framework to explore pedagogical action? Research suggests that technologies should function as intellectual toolkits that enable students to build more meaningful personal interpretations and representations of the world (Jonassen, et al., 2010).

#### **1.1.4 ICT and Initial Teacher Education**

The adaptation of ICT has in turn called for education reforms at various levels, with a view to creating an enabling educational environment for future generations to effectively function in the digital era. Therefore, teachers' capacity of integrating ICT into their teaching practices plays a critical role in achieving the goals of education reform. In this regard, Teacher Education Institutions (TEIs) have made great efforts to incorporate ICT components into their teaching and learning programmes (UNESCO, 2013). The infusion of ICTs may be a very complex, multifaceted process that may involve, not only technology, but also infrastructure and sustainability of resources, curriculum review and restructuring, instructional readiness, lecturer capability and adeptness with pedagogical reorientation.

Admittedly, having ICTs in the Initial Teacher Education environment does not automatically ensure that high quality and effective teaching will take place (Rastogi & Malhotra, 2013); it may change the lecturer's role but not necessarily transform pedagogy. Therefore, effective pedagogical transformation or alteration requires lecturers, especially teacher trainers, to believe and accept ICTs as a valuable education transformational tool that could improve the teaching-learning process. It is therefore essential for lecturers to ruminate on their ICT capability and skills and relate these to ICT-pedagogical integration to improve teaching and learning, since

education has embraced it as a necessary framework for rigorous, effective and efficient curriculum delivery.

### **1.1.5 ICT and Mathematics, Science and Technology education**

One contextual factor which appears to mould how technology is perceived and used by lecturers and students is the 'community of practice' associated with these subjects. It is within this framework that planning, learning and teaching and engaging technology takes place (Hennessy, et al., 2013). Each subject community possibly shares a set of values, approaches to teaching and learning, expectations and aims, as well as practices.

#### **1.1.5.1 ICT and Mathematics education**

In previous generations, mathematics was seen as a subject full of rules, drills and exercises. However, in the contemporary setting, mathematics should be seen as an exploration where rules emerge from understanding. Can ICT help? It depends on the lecturers approach and use of technology in conceptualising mathematical issues. The aim of integrating digital technology into mathematics education is not to provide students with a new 'technology toy' but rather to create an active learning-enabled environment for the development of conceptual knowledge (Hoong, 2010).

ICT promotes collaborative problem-solving which enhances the complex interactions of students and lecturers, which is an essential attribute of conceptual understanding in mathematics. ICT integration in mathematics education also necessitates iterative and continuous work for designing, experimenting, and adjusting resources, while at the same time developing collective activities - ideally through communities of practice (Sautre, et al. in Trouche, 2008).

Integrating ICT into mathematics education requires a careful understanding of the ways in which technologies can be productively used to achieve conceptual understanding and to develop skills. However, it is important that, for effective embedding within the subject, lecturers and student teachers must embrace self-development and growth in order to expand and adjust their teaching repertoires.

### **1.1.5.2 ICT and Science and Technology Education**

The prevalence of ICT offers a challenge to the teaching and learning of science and technology education. ICT, for example, offers a range of different tools for use in science classroom practice. These include: tools for data capture, processing and interpretation; multimedia software for simulation of processes and carrying out 'virtual' experiments; computer projection technology; information systems; digital recording equipment; and modelling environments. These forms of ICT resource can enhance both the practical and theoretical aspects of science teaching and learning. However, it is important for lecturers and students to develop an ICT knowledge base and the necessary pedagogy, to select the appropriate technological resources for designing structures that will support teaching and learning (Osborne & Hennessy, 2003).

In effect, how lecturers harness the powerful potential of using ICT to support learning science through creative and innovative teaching, as well as developing skills in students, may depend on their clear understanding of the technology and pedagogical positioning.

### **1.1.6 ICT as enabler for creativity and innovation**

The role of ICT in the debate for creative and innovation in teaching and learning mathematics, science and technology education is vital with the upsurge of varied technology tools and resources, such as the internet. The evolution in communication practices suggests that developments for pedagogy need to be addressed (Loveless, 2008) in these subjects, in order to avoid producing 'yesterday's teachers for tomorrow's learners'. For creativity to be triggered requires knowledge, though the opposite may also happen. However, creativity allows for the making of connections across different areas of knowledge (Burke, 2007), hence this becomes a form of knowledge creation. For students to be creative requires an innovative role to be played by the lecturer.

Any kind of teaching addressing creativity through appropriate teaching methods and content can be seen as innovative teaching. Innovative and creative use of technology requires students and lecturers to have an understanding of the

technological skills to manipulate resources in order to make connection between old knowledge and new.

A major enabler for generating creative learning and innovative teaching is pedagogy. If technologies are adopted, but their usage is a reproduction of traditional formats, their impact on creativity will be minimal, and may also see a shift in subject cultures.

## **1.2 ICT INTEGRATION IN SOUTH AFRICA**

The use of ICTs in teaching and learning has become an integral driving force in the South African educational context. This is evident in the National Plan for Higher Education (DoE, 2001), the National Research and Development Strategy (Department of Arts, Culture, Science and Technology, 2002), where the National Research and Technology Foresight Report (Department of Science) and policy documents argue the important role of Information Communication Technology (ICT) in education. This emphasises how it 'adds value' to education, improves teaching and learning, encourages innovation and contributes to transformation (Czerniewicz, Ravjee & Mlitwa 2005). However, its benefit and value added contribution in education can only be maximised if technology is pedagogically integrated in teaching and learning.

Learning at tertiary level is more of a dialogue, engagement, collaboration, interaction and communication for knowledge construction, so that integration of technology in such educational environment could offer unprecedented opportunities for productive teaching and learning. However, the frequent use of ICTs in searching for information might shift the focus from other possibilities in the teaching and learning process, resulting in over-dependence, which could prevent critical thinking.

### **1.2.1 Research on ICT integration in South Africa**

ICTs are dynamic and considered as basic requirement for the knowledge society for which universities now prepare students (Castells, Flecha & Freire, et al., 1999), so a regular investigation into its integration in teaching and learning, to meet the changing dynamics, is of paramount relevance.

Czerniewicz and Brown (2005) explored through a quantitative study, and discussed, how ICT is being used as part of teaching and learning events, the extent to which it is being used in teaching and learning events, and how it is used by specific groups as part of particular teaching and learning events in higher education in the Western Cape (SA). Czerniewicz and Brown (2005) reported that ICT supports teaching and learning activities however, they noticed that students use it beyond lecturer instructed learning activities. This, Czerniewicz and Brown (2005) contend, opens the door for questions about staff-student interactions regarding ICT integration. It is worth understanding that Czerniewicz's and Brown's (2005) interpretation of ICT integration has to do with the combined use of digital resources and how lecturers perceive teaching to be organised, and, on the other hand, how students contextualise learning.

Krull (2012) also revealed ICT integration in the areas of research, teaching and administration and found key trends such as; technology use being increasingly cloud-based, notions of IT support being decentralised, and a resounding emphasis on more challenge-based and active learning. Furthermore, he contends that the relationships via the internet are increasingly challenging educators to realign their roles. Also, admitted that there are other challenges, such as the continual rise in digital literacy as a key skill in every discipline of teaching and learning.

Moll, Adam, Backhouse and Mlanga (2007) found that HEIs initiative on ICTs is located in the National Infrastructure provision which does not clearly outline implementation or integration policy guidelines. It therefore appears that institutions guided by this provision have the autonomy to draft their own integration policy. However, ITEs which are expected to train teachers to implement the provisions of the White paper on e-education which addresses integration in schools are guided by this policy.

### **1.2.2 White Paper on e-education Policy framework**

The paper acknowledges in its policy goal that “every South African manager, educator and learner in the general and further education and training bands will be capable of confidently and creatively using ICTs in order to participate in a global community, by 2013” (DoE, 2004:17). This implies that teachers and learners must

be ICT capable, and all teachers must integrate ICTs into teaching and learning practices (Blignaut & Howie, 2007).

The policy proposed approaches for the use of ICT in education, such as the use of multimedia applications, to create contexts for problem-solving, draft analysis and the creation of knowledge in the learning process.

The policy stipulates strategic objectives, such as; ICT professional development for teaching and learning, electronic content resource development where teachers are equipped and capable of contributing towards the development of electronic materials for teaching and learning. This then draws on ITEs to provide students with the basic ICT knowledge, skills and attitudes required to integrate technology into subject specialization.

The policy enumerated implementing strategies; namely, system-wide approaches, co-ordination, collaboration, monitoring and evaluation. It also set planning cycles with time lines for implementation. Phase I – 2004/07; Phase II – 2007/10 and Phase III – 2010/13, which guide the initial medium-term process of integrating ICTs into e-learning. It is expected that at Phase III successful integration of ICTs will be present at all levels and institutions and across the curriculum.

This policy has ramifications for student teachers, lecturers and others involved in ITE and curriculum delivery, with the role of lecturers being essential and valuable, while not ignoring a relook at curriculum delivery.

### **1.3 ICT INTEGRATION IN EDUCATION: UNRESOLVED ISSUES**

Although valuable efforts have been made to integrate ICT into the educational system, there are also significant challenges that need to be considered. These include the digital gap between the students and lecturers, and lack of guidelines on the approach to integration.

#### **1.3.1 Digital divides between students and lecturers**

Feenberg's (1999) research points to the issue of the digital gap between lecturers and students. The digital culture in which students are growing up, the digital

practices they bring to the educational environment, and the academic practices they need to acquire in the formal educational system, (notwithstanding the fact that students now register and sometimes write some examination papers online), motivate them to appreciate, learn, perfect and continuously improve their ICT skills. Lecturers, on the other hand, are not subjected to such compelling situations, due to the policy structure of engaging technology in teaching and learning. Therefore, lecturers, especially in MSTE, have to reposition their pedagogy to minimise the tension between technology and learning theories.

### **1.3.2 Lack of ICT integration guidelines**

In South Africa, policy support for ICTs in education is manifest in numerous documents, including the National Plan for Higher Education (2001), the White paper on e-Education (2004), the strategy for Information and Communication Technology in Education, (DoE, 2001) and the National Research and Development Strategy (DoST, 2002), amongst others. However, there is no distinct national policy guiding the integration process. Institutions design internal policy documents to incorporate technology into teaching and learning. Seemingly there is no monitoring strategy, or pedagogical guideline clearly stated to enforce integration

The South African government White Paper on e-Education (DoE, 2004) outlines plans for incorporating technology into education and phase frames. However, there is no mention of the paradigm dimension of integration; neither does it address pedagogical orientation.

In all these cases there seem to be no clear and distinct directives on how integration should be done. Discussions, in both national and institutional policy documents, only emphasise the supply and use of computers, desktops, laptops and servers that are needed in institutions. The internet is referred to, but the discussion is more about rolling out computers and their accessibility to students and lecturers. Therefore, it seems to me that, in most of the discussions related to ICT integration in education, the default meaning is computer based learning. So, what happened to ICTs and integration guidelines?

There have been several research studies conducted on teachers' inability to integrate ICTs into teaching and learning, and the findings have been documented

(Hodgkinson-Williams, 2006; Bingimlas, 2009; Fu, 2013). Literature identifies various factors that influence effective integration of ICT, but mostly viewed in isolation (Chen & Chang, 2005). Such factors include:

Teachers' inadequate ICT knowledge base and competency, indicating that the training they were offered lacks the appropriate integration models.

How lecturers integrate technology in their practice, but still use technology in the traditional way.

Interacting with literature revealed that, in South Africa, not much research has focused on ICT integration in Higher Education programmes.

#### **1.4 MOTIVATION FOR THE STUDY**

HEIs are integrating ICTs into their educational programmes. However, there seems to be little literature on the pedagogical structure in which lecturers, including teacher trainers, employ ICT in their curriculum delivery. ITE produces educators who are expected to implement ICT integration in schools, but the policy framework on e-Education (DoE, 2004) is silent on the integration of ICTs in Higher Education

Therefore, it is important to understand how integration in HE takes place, hence this study focuses on the pedagogical integration of ICT in mathematics, science and technology education

#### **1.5 PROBLEM STATEMENT**

Several education research topics and published articles are directly related to ICT in teaching and learning, its benefits and challenges. Lecturers of ITE are expected to integrate technology in the teaching and learning process, so that it supports instruction and enables students to use ICT tools to meet their information needs and to construct knowledge; to develop conceptual understanding through collaboration with peers, lecturers, and experts, as well as to develop the necessary skills towards life-long learning.

There is a great deal of research and literature (Hennessy et al., 2013; Tay, 2012; Webb, 2008; Jung, 2005) which emphasizes ICT integration pedagogy as a tool for improving learning. However, little is known about how the integration of ICT transfers knowledge and skills to the trainee teacher educators. This study sought to discover how lecturers of the three learning areas in initial teacher education integrate ICT in their teaching and learning.

## **1.6 PURPOSE OF THE RESEARCH**

The main intent of this case study is to obtain a more in-depth understanding of how ICT is being integrated into teaching and learning by mathematics, science and technology education lecturers. Furthermore, how do students learning these subject areas engage with ICTs among themselves and with lecturers, to construct knowledge, conceptual understanding and to develop skills for their professional practice. The study also explores lecturers' innovative use of ICTs in curriculum delivery, and students' creative application of technology in their learning process.

## **1.7 RESEARCH QUESTION**

This research aims to address the main question in 1.7.1. However, the subsidiary questions in 1.7.2 are posed to provide further insight into the main question.

### **1.7.1 Main question**

How is ICT integrated in teaching and learning of mathematics, science and technology education (MSTE) in a Bachelor of Education programme?

### **1.7.2 Sub-Research questions**

- How are MSTE students' and lecturers' belief systems (ontology) and perceptions (epistemology) reflected in the integration of ICTs in teaching and learning?
- In what ways are ICTs used to support students' innovation and creativity in MSTE?

- How are ICTs used to support students' conceptual understanding of mathematics, science and technology education?

## **1.8 THE SIGNIFICANCE OF THE STUDY**

It is widely accepted that South African institutions of learning are struggling with the implementation of the e-Education White paper, since its advocacy in 2003. Several challenges hindering the progress of integrating ICTs in institutions have been outlined, and some investigated.

According to Costello (2000) a revolution in education is necessary to create equal opportunities for all, and ICTs could be used to achieve this through rapid improvements in teaching and learning.

The researcher seeks to understand how the ICT pedagogy of mathematics, science and technology education lecturers in ITE articulates the use of technology tools in teaching and learning for conceptual understanding, and knowledge construction, and how the use of ICTs translates into a conceptual change in the teaching and learning of mathematics, science and technology. The findings from the investigation could assist ITE curriculum delivery and other programmes at HEIs, notwithstanding the influence on lecturers' pedagogy, epistemology and ontology. Also, HEIs could use the findings in equipping lecturers with phenomenal ICT skills for effective ITE curriculum delivery. Authorities should take account of, and build up, the level of technological expertise of students and lecturers. Lecturers would constantly evaluate the unique contribution of ICT and its specific role in enhancing teaching and learning activities.

At national and institutional levels, the findings could provide a platform for the restructuring of ICT policy with intervention parameters on integration and implementation of ICT in teaching and learning in tertiary education space.

The findings could also give direction to related future research on ICT integration in teaching and learning.

## **1.9 RESEARCH METHODOLOGY**

This section presents a brief discussion on the research approach, data collection and data analysis in the study. However, a comprehensive discussion is detailed in chapter 3.

### **1.9.1 Research Approach**

A qualitative dominant case study design was adopted for this study after carefully examining the nature, paradigm and focus of the study. Secondly, the researcher was the primary instrument who collected and analysed the data, and was in close contact with the participants. Merriam (2009) suggests that qualitative inquiry requires the researcher to describe, explore and interpret phenomena in their natural setting in order to produce data which are credible and verifiable. The underlying principle of qualitative design is to understand the meaning which *people*, in this case students and lecturers, have constructed, or how people make sense of their *world* (learning environment) through their experiences (Lichtman, 2006). This is what the research wishes to unravel in the study. Furthermore, qualitative research can reveal how all the cases described in chapter 3 worked together to form a whole.

Using a qualitative descriptive approach, data was gathered and analysed, pertaining to ICT integration, opportunities and challenges of integration, into teaching and learning, the pedagogical deliveries, and the lecturers' epistemological and ontological assumptions with regard to ICT integration.

The use of qualitative design facilitated the exploration of the participants' practices and experiences of ICT integration in course delivery and learning, and their practices, using technology for skills development and knowledge construction.

### **1.9.2 Data Collection**

The instruments employed in the data gathering process included a self-administered open-ended questionnaire, a semi-structured interview schedule based partly on the responses obtained from the participants to affirm the data collected through the questionnaire, and also to probe further the participants' pedagogical integration of ICT and documents. The structure of the questionnaire and the leading questions in the interview allowed the respondents to express themselves to the best of their ability, and also offered an opportunity for them to explain issues that arose

in the course of the conversations. These are popular data collection techniques used in qualitative studies, and regarded as conversations with purpose.

### **1.9.3 Data Analysis**

The analysis of data was designed to provide understanding of lecturers' and students' approaches to ICTs as tools for knowledge construction, and 21<sup>st</sup> century skills development. The data collected through the instruments were subjected to a descriptive approach. To ensure research rigour, the questionnaire and interview questions were standardised through a pilot study and content analysed, based on Punch's (2005) model of qualitative data analysis.

### **1.10 DELIMITATION**

The issue of pedagogical orientation became very relevant, playing an important role as the dominant principle that shapes ICT integration. In this study, the focus is on how lecturers integrate ICT in teaching and learning in mathematics, science and technology education, within the Initial Teacher Education curriculum.

### **1.11 KEY CONCEPTS**

The core concepts used in this qualitative study are explained in the following chapters. However, a few are described below:

*Analysis* – The process of sorting, arranging, coding, and in other ways looking for patterns in data for the purpose of coming up with findings.

*Conceptual understanding* – An integrated and functional grasp of concepts and ideas blended with knowledge and skills. It is a problem-based interactive process with emphasis on connections.

*Communication technology* - Describes telecommunication equipment through which information can be sought, sent and accessed (such as phones, faxes, modems and computers).

*Contemporary theories* – A collection of theoretical approaches which are marked by a number of premises. Are modern theories abstracted from classical theories?

*Creative learning* – Purposeful thinking, or behaving imaginatively, to generate something original that must be of value in relation to the objective.

*Curriculum delivery* – The many ways in which curriculum assists students to achieve their learning objectives, including teaching, and learning support, mentorship, collaborative learning, tutorials, skills development and practice, and access to resources.

*Data* – The rough materials that the researcher collects from the world being studied (participants); the information that forms the basis of analysis.

*ICT integration* in this study is defined as a process of using ICTs, such as information and communication resources, learning objectives and pedagogy to enhance learning.

*Information technology* describes items of equipment (hardware such as personal computers, cameras) and computer programmes (software such as database programmes and multimedia programmes) that allow us to access, retrieve, store, organise, manipulate and present information electronically.

*Information and Communication Technologies (ICTs)* - A convergence of information technology and communication technology, and hence a combination of networks, hardware and software, as well as the means of communication, collaboration and engagement that enables the processing, management and exchange of data, information and knowledge

*Innovative teaching* – A teaching approach that emphasises critical thinking, problem-solving, creativity and collaboration.

*Integration* - Is a means by which all essential elements of a system are seamlessly combined to make a whole.

*Knowledge construction* – Knowledge discovered from exploration, or inferred from constructs (mental models made to fit a particular frame of reference) by examining and questioning the available information.

*Respondents* – Persons from whom information is gathered to answer the research question.

*Teaching* – The act of impacting or facilitating the construction of knowledge. It involves undertaking certain ethical tasks or activities with the intent to induce learning

## **1.12 OUTLINE OF THE CHAPTERS**

The study is presented in six chapters, as follows, with a summarised outline in chapter six.

### **Chapter 1 – The study orientation**

This chapter presents a brief introduction to, and background of, the study and its uniqueness of purpose. The chapter also presents the primary question, as well as the derived questions that guided the study process. A summary of the theory upon which the study was built, the significance, motivation, problem statement, delimitations and definition of some concepts are also presented in this chapter.

### **Chapter 2 – Literature review**

This chapter locates the study in a literature domain, identifies and examines appropriate literatures that inform the study. The chapter presents a debate on international research, as well as local perspectives and research of the issues being explored. The debate ranged from the school environment through to the tertiary landscape. It also focused on the theoretical framework of the study.

### **Chapter 3 – Research methodology**

This is an interpretive qualitative case study, and as such the exploratory approach and discussion are within that spectrum. This chapter describes the research assumptions, paradigms, approach and design, and data collection techniques, as well as the data analysis approach. Limitations and research rigour are also discussed in this chapter.

### **Chapter 4 – Data presentation and analysis**

The fourth chapter deals with the data. In this chapter, the data obtained from the participants through questionnaires and interviews are presented and analysed. The chapter begins by describing the demographic characteristics of the participants and

is followed by the presentation and analysis of data categorised under the emergent themes.

### **Chapter 5 – Discussion of findings**

Chapter 5 focuses on the findings derived from the study. The chapter discusses the evidence underpinning the lecturers' and students' theoretical approaches to the integration of ICT in teaching and learning. It then discusses the ontological and epistemological orientation of the lecturers and their relationship to the learning theories of ICT. It also discusses the use of ICTs for innovative teaching and creativity, and the use of resources for conceptual understanding. The chapter concludes by presenting a summary of the findings of the study.

### **Chapter 6 – Summary, Conclusions and Recommendations**

This chapter presents a synoptic overview, a summary of the main ideas and findings from the study, and concluding remarks based on the data analysis. The potential contributions of the study, as well as the limitations of the study, are provided. Recommendations are tabled, and areas for possible further research are proposed. The chapter concludes with a brief reflection on the research journey.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2. INTRODUCTION**

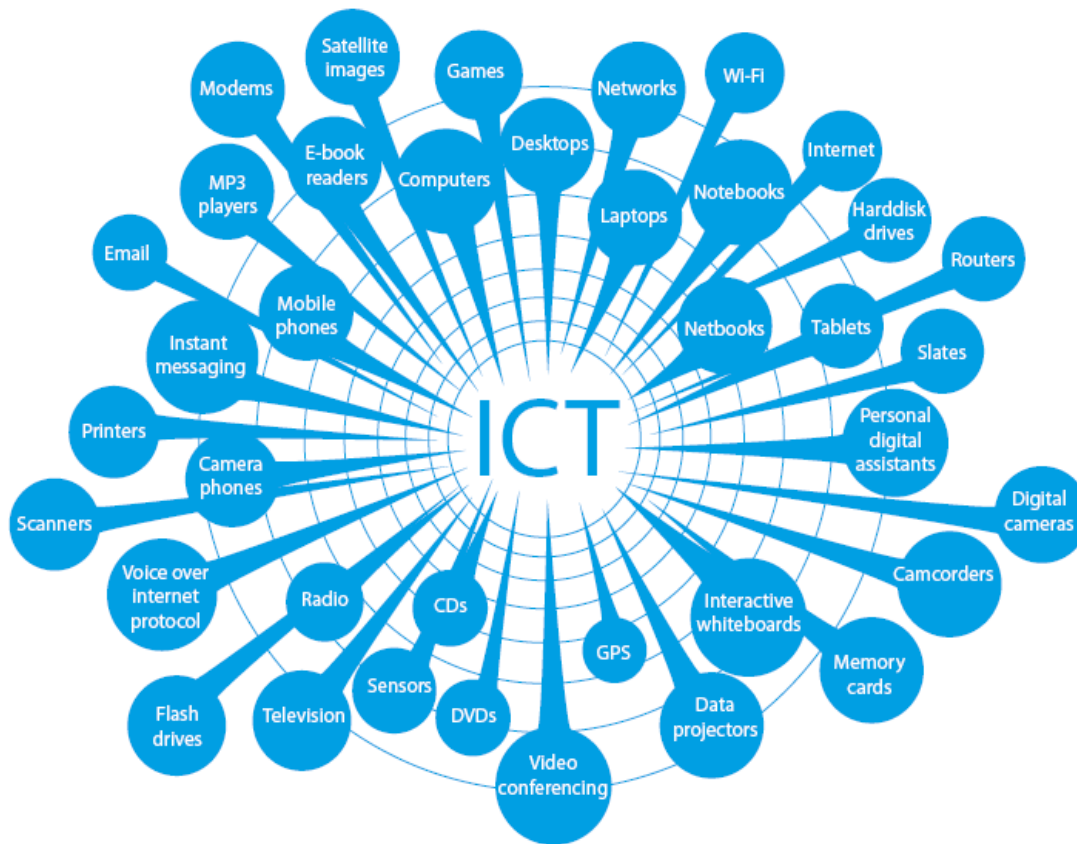
We are experiencing an explosion of information and technological advancements; a world of greater interconnectivity, coupled with accelerated flow of information and data, with decreasing time and international boundaries being driven by a functional force. The force driving this rapid revolution in communication, transforming the world from isolated islands to interconnected super highways is Information and Communication Technologies (Herselman, 2002). This phenomenon aroused the interest of many researchers to investigate the important role of information and communication technologies (ICTs) in education, and the variety of approaches to integrating ICT-pedagogy in ITE, as well as arguments against the use of ICTs in education. Effective integration of ICTs in teaching and learning at ITE requires pedagogical alteration or pedagogical transformation of lecturers.

This chapter reviews the relevant literature that contributed to addressing the pertinent question of the study, namely: How is ICT pedagogically integrated in MSTE in ITE? To effectively engage with this question, this review explored the following issues: (i) overview of the concept of ICT (ii) integration of ICTs in education and its impact (iii) ICT pedagogy integration and influence (iv) limiting factors to ICT integration

#### **2.1 OVERVIEW OF THE CONCEPT: ICT**

Many different terms are used to describe various sets of ICT-related curricula, which include cognitive tools (Solomon, 1996) mind tools (Jonassen, 2000). Tagg cited in Kaffash, Kargiban, Kargiban and Ramezani (2010) defines it as a tool to extend the curriculum method, content, product and process to new and useful territories which have not been possible in the past. Most researchers suggest ICT as a combination of computer, video and telecommunication technologies, as observed in the use of multimedia computers and networks and also services which are based on them (Van Damme, 2003). Figure 2.1 below shows the technologies that are combined to form ICT, after which the discussion shifts focus onto the

concept ICT as used in education.



ICT Transforming Education: Regional Guide

<http://unesdoc.unesco.org/images/0018/001892/189216e.pdf>

**Figure 2.1: The composition of ICT**

### 2.1.1 The concept of ICTs in education

It is necessary to explain the concept of ICTs in education, how it is understood and used, since it is central to this study. ICT in education has three main aspects: (i) learning from ICTs, whereby technology facilitates learning across the curriculum, (ii) learning about ICTs in which technological literacy is the end goal, and (iii) learning through/with ICTs by integrating technological skills development with curriculum applications (Webb, 2008). Furthermore, the use of ICT for educative processes has been divided into two main broad categories as ICTs for education – which emphasise the development of ICTs specifically for teaching and learning purposes, and ICTs in education, which incorporate the adoption of general components of

ICTs in the teaching and learning process. It is interesting to note that the terminology ICTs is a 21<sup>st</sup> century adoption, as described earlier in chapter 1.

Due to rapid technological transformation and developments (Voogt & Knezek, 2008), these technology descriptive frames keep changing. For instance, the initial terminology 'computer technology' has been replaced by ICTs and has gradually being popularly referred to as information technology (IT) due to the rapid change in the parameter of tools and resources and coverage, though, for now, ICT and IT are often used interchangeably. ICTs include all technologies used for processing information, communicating, storing, access and use of information to support information and communication activities (Andrews & Haythornwaithe, 2007). In brief, Van Damme cited in Kaffash, et al. (2010) explains ICTs as a combination of computer, video and telecommunication technologies, as observed in multimedia computers and networks, and also services which are based on them. However, within the frame of curriculum delivery and enhancement, ICTs may also include cognitive and mind tools. In discussing the concept of ICTs it is also important not to overlook the terminologies one encounters.

Researchers, academics, academic commentators, and technology practitioners, amongst others, use varied terminologies to drive ICT concepts, which mostly reflect the purpose for which the technology is used. In education, the terminologies mostly encountered include: Educational Technologies (UCT, 2003), Learning and E-Learning Technologies (Badenhorst & de Beer, emerge 2004), Online Teaching and Learning Technologies (Van der Merwe, & Möller, 2004), Digital Library Technologies (Peter, Dale, CITTE, 2002), and Digital Learning Objects (Smith, 2004) all cited in Mlitwa (2005). Similarly, within the context of communication technology are communication tools, and or networks, with the most frequently used terminologies as; IT Networks and Communication Protocols (University of Natal, 2003 cited in Mlitwa, 2007), Electronic Information and Communication Technologies (Van der Merwe & Pool, 2002), Information Agent (Razek et al. 2003), or just simply Communication Technology (Blanchette & Kanuka, 1999) - all cited in Mtilwa (2007).

Comprehensively, Educational Technology encompasses computers, video, software, and communications interactive video, satellite communications,

televisions robotics, CD-ROM and the internet. It also includes the knowledge and skills required to appropriately use the tool.

In summary, ICT comprises many technologies for capturing, interpreting, storing and transmitting information, the detail of which is illustrated in the table below. However, not all these entities are used in education. The discussion in table 2.1 below clarifies which ICTs are mainly used in education, and the areas where they are most applicable, with illustrative applications.

### 2.1.2 Types of ICT in education

In order to understand the relationship between pedagogy and technology, this section adopted Scott, et al.'s (2010) framework that describes teaching and learning interactions, contextualizes them by name, the types of ICT used, categorises the types, and explicitly links them to particular teaching and learning events.

ICT type	Description	Use in Investigation	Example
Analysis software	Programme that helps people organise, process and communicate information	Aid thinking, Aid communication	Intel's online. Thinking tools Mind mapping software
Animation software	Programmes that make pictures move, say on a computer screen	Creating and viewing moving images to illustrate processes in presentation	Toonboom
Audio-visual recorders	Recorders for capturing audio (sound) and visual (sight) information	Recording visual or auditory data	Video and photograph cameras. Webcams. Voice recorders.
Calculation and graphing software	Programmes that perform calculations and draw graphs	Transforming and representing data.	Microsoft Excel
Computer-linked lenses	Lenses connected to computers. These may be hand-held or connected to a microscope. The	View, capture and project magnified images electronically	ProScope. Webcams, fitted with appropriate lenses, feed magnified data to a computer.

	image focused can be seen on the computer		
Data loggers: probes and sensors	Electronic device that take measurements and display these on screen	Measuring. Collecting data	Infrared emitters and sensors for timing the movement of an object past a probe. Global Positioning Systems (GPS)
Information systems	Sources of information	Accessing information	Encarta. Internet information
Networking technology: synchronous	Technology that connects people simultaneously, allowing them to communicate in real-time (no delays)	Collaboration. Communication in real-time.	Chat, telephone conferencing, Wifi/Bluetooth enabled cellphones, PDA's, Senteo interactive response systems
Networking technology: asynchronous	Technology that connects people, allowing them to communicate even if they are not using the technology at the same time	Collaboration. Communication.	E-mail, web conferencing, blogs, wikis, discussion forums, SMSs.
Presentation software	Programmes for displaying information	Reporting	Microsoft PowerPoint, Microsoft Word
Projection technology	Hardware for projecting information from a computer-screen onto a large screen	Allowing large groups to view and interact with data.	Interactive whiteboard. Data projector
Simulation software	Programmes for doing virtual experiments on a computer. The programme is designed to behave like the real situation it is simulating.	Virtual experimenting. The user can manipulate variables, and take measurements of the consequence of this. Perform virtual dissection.	Free simulations downloadable from the internet. Commercial packages
Learning	Programmes to	Assists with	Moodle.

management systems	set up electronic courses and to monitor learner progress.	organising, collaborating and communicating.	Blackboard
Video production, editing and viewing software	Programmes for making video.	Display and view audio-visual information.	Windows movie maker. Windows media player. CamStudio (screen capture videoing software)

**Table: 2.1 Types of ICTs** (Adapted from Scott, Kibrige & Webb, 2010:149-151)

### 2.1.3 ICT development in education

Effective use of technology depends on how it has been infused into pedagogy so that its use can improve learning. Adequate infusion requires lecturers and students to have the core qualities of the stages of ICT development. According to UNESCO (2005) the broad stages that the educational system, including lecturers and students, have to proceed through in the adoption and use of ICTs, are termed as Emerging, Applying, Infusing (Integration) and Transforming. However, these stages are conceived as a continuum and mapped on the basis of stages of ICT usage and pedagogical usage.

At the emerging stage, the focus is on technical functions and the use of ICT. At the same stage lecturers and students begin to explore the possibilities and consequences of using technology in instructional delivery; however, they use it for personal issues. It must be remembered that lecturers and students still operate in the conventional paradigm.

In the applying stage, ICT tools and resources are integrated in subject content delivery and are used, only to reinforce learning (Senapaty, 2012). However, lecturers use ICTs for professional development, in order to improve their teaching and to help change their teaching methodology in the classroom.

The third stage involves the integration and embedding of ICT in curriculum delivery. Lecturers explore avenues which change personal productivity and professional development, and use ICT to support active and creative learning, and to stimulate and manage students' learning. They use ICT to assist all students in assessing their

own learning, while at the same time collaborating with others in solving problems and sharing teaching experiences.

The transforming stage is where ICT becomes an integral component of the lecturers' and students' daily professional and productivity routine, with a complete change from a teacher-centred to student-centred learning and teaching approach, thus integrating learning in real-world applications.

For lecturers and students to use ICTs effectively, they must be able to identify emerging productivity tools, learn how to use them to their full potential, and demonstrate an understanding of how and when to use the appropriate ICT for a particular task (Senapaty, 2012).

Pedagogically, these four stages are linked respectively to the stages of ICT development. The first stage is where ICT supports work performance through the use of productivity tools, to support teaching and learning, with emphasis on basic operations of electronic office suites. The second stage involves enhancing traditional teaching. Here, techniques of technology-based learning are integrated into the traditional domain. The next pedagogical stage is where various ICT tools are used to facilitate student learning. This involves recognising the situation where multimedia and specialised software are utilised in teaching and learning. The final stage involves creating an innovative learning environment that transforms learning situations. This is achieved by incorporating emerging trends in pedagogy, and learning principles in teaching and learning. At this stage, specialised software, such as modelling, simulation, expert systems, and semantic networks, are engaged with to support pedagogical innovation.

Below is a summary of ICT developments in education.

Stages of ICT Usages	Stages of ICT Development	Pedagogical usage of ICT
Becoming aware of ICT and identifying productivity tools	← <b>EMERGING</b> →	Applying productivity tools in teaching and learning
Learning how to use ICT in subject teaching and learning	← <b>APPLYING</b> →	Enhancing traditional teaching and learning
Understanding how and when to use ICT	← <b>INFUSING</b> →	Facilitating learning using multi-modal instruction
Specialising in the use of ICT	← <b>TRANSFORMING</b> →	Creating innovative and open and free learning environments

**Table 2.2: Stages of ICT usage, development and pedagogical usage (Source: UNESCO, 2005)**

## 2.2 ICT INTEGRATION IN EDUCATION

The purpose of integrating ICT in education is to advance quality teaching and learning, and to improve conceptual understanding by students. However, the potential of ICTs to support pedagogy is yet to be fully achieved, due to technical and non-technical factors that affect the adoption of ICTs for curriculum delivery.

In the next section the researcher explains the concept of ICT integration relative to teaching and learning, and contextualises it in the domain of this study.

### 2.2.1 Explaining ICT integration

Historically, ICT emerged from the concept of IT (Sansanwal, 2009) which basically means computer technology for information abstraction and delivery, as its principal

role. However, with the emergence of web, communication and digital data networks, the IT concept had limitations and had to be extended to take into consideration the new technologies. To refine the definition requires a redefined concept within the construct of ICT.

Some authors attempted to explain their understanding of ‘ICT integration into curriculum’ by describing the range of ways and approaches for the use of ICTs in learning and teaching (Hodgkinson-Williams, 2009; Senapaty, 2012). This view is distinct from the opinion concerning the structure and design of curriculum emphasising the portions which relate to a specific ICT resource. According to Flanagan & Jacobsen, cited in Hodgkinson-Williams (2006), technology integration is more cross-curricula than a separate course or topic on its own. Other authors, in their attempts to explain ICT integration, considered it as areas or levels of integration (Wang & Woo, 2007; Bialobrzaska & Cohen, 2005) which has been discussed in the next sub-section.

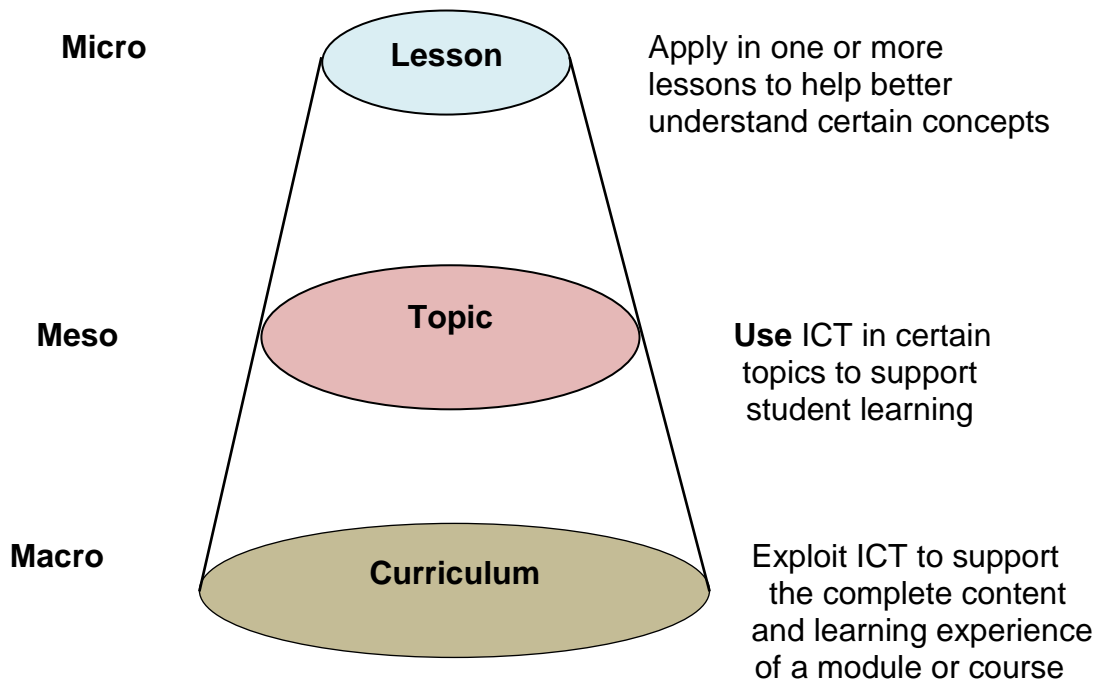
Considering the definitions from these authors, one can say that ICT integration in the 21<sup>st</sup> century learning environment, involves all the stages of ICT development. ICT basically is a tool. It can be hardware (such as computers, digital devices and communication systems) or software (such as word processing suites, discussion forums, internet media and others).

Integration, on the other hand, is a means by which all essential elements of a system are seamlessly combined to make a whole (Earle, 2002). This means that, in education, simply handing students a collection of relevant websites is certainly not integration. However, integration takes place if ICT and other crucial educational components, such as content and pedagogy, are moulded into one entity.

Assembling these two definitions, ICT integration in this study is defined as a process of using ICTs, such as information and communication resources, learning objectives, and pedagogy to enhance learning. It is expected that in the contemporary educational environment, pedagogical integration should promote a student-centred approach in the teaching and learning process.

## 2.2.2 Levels of ICT integration in education

Integrating ICT into teaching and learning has become a great concern for many educators (Wang and Woo, 2007). According to them, ICT integration can happen in three areas, namely; curriculum (macro), topic (meso) and lesson (micro), as illustrated in figure 2.2 below.



**Figure 2.2: Areas of ICT integration**

Similarly, Bialobrzeska and Cohen (2005) claim that there are three levels of integrating ICTs into learning, namely, functional practice, integrative practice and transformational practice. Functional practice is the stage when students use computers in basic functional ways to do the things that the computer can do well. This includes searching for information on the internet, word processing, producing graphs, etc. By contrast, when students use programmes to engage in more challenging activities, such as drawing or designing a house, this constitutes integrative practice. The third level is “characterised by learning which occurs as a result of activities and opportunities which do not exist in a computer-based environment” (Bialobrzeska and Cohen 2005: 33) such as collaborative online projects and synchronous chats.

However, the integration of ICT at these levels depends on the scope of the content

and the capability of the lecturer.

### **2.2.3 Perspectives on ICT use in Higher Education Institutions (HEIs)**

Academics, researchers, students, administrators and other stakeholders hold their own views on the influence of ICTs, if effectively integrated in HEI learning environment. One perspective of ICT integration in HE is to advance student-centred curriculum delivery to encourage the construction of knowledge, thus moving away from the traditional technologies that emphasise knowledge transfer through mere lecturer-centred mechanistic content delivery. With this perception, researchers acknowledge that ICTs improve the quality of teaching and learning in a HE environment.

Further, researchers acknowledge that computers enhance teaching and learning through many channels, including 'presentations', 'simulations' and 'animations', among others, and offer students and academics the opportunity to practise and analyse more carefully with adequate understanding, through accessing more sources via the Internet, to authenticate information (Brown, 2002). Again, computers and Internet connectivity have been indicated to enhance communication and interaction between colleagues and peers both locally and internationally (Brown, 2002), which improves collaboration as well as knowledge dissemination. Seemingly, using the computer and the Internet breaks the cultural boundaries between students and lecturers and between students and academics and institutions as well. Research established that within a pedagogical context, presentation is an instructional perspective which is greatly improved by the use of ICTs.

It is also perceived that at HEIs, the use of ICTs motivates students (Hawkins, in van der Merwe & Mouton, 2005) and encourages them to take responsibility for their learning, while at the same time being accountable and contributing immensely to building their confidence in whatever they study, in order to support the knowledge society. It is conceived that in HE, ICT benefits are without pedagogical bias, and that they enhance educational processes from any perspective, depending on how they are engaged.

Research and distance learning (education) are some areas where HEI's play an important role in academic and professional development. Within these contexts, ICTs are perceived as breaking the barriers created by distance, time and direct or physical contact with entities, through the availability of electronic media (facilities) which bridge any physical gaps between students or lecturers through online information (Bowen, 2001).

Extensive research around the world has also shown that using ICTs in teaching and learning has a positive impact on learning outcomes and on education equity. Furthermore, ICTs transform teaching and learning environments, with the understanding that learning is an on-going lifelong activity where students seek knowledge through the engagement of resources and sources to make sense and meaning of issues. Numerous studies have revealed that the appropriate use of ICTs can raise education quality, and connect learning to real-life encounters and situations (Lowther, Inan, Strahl & Ross, 2008; Barolli & Servrani, 2009; Cross & Adam, 2007).

However, these perceptions on ICT-enhanced learning come with challenges, which will be discussed later.

#### **2.2.4 Integrating ICTs in initial teacher education**

It is important to acknowledge that integrating new technologies, together with effective pedagogical alignment, is a daunting task for tertiary institutions including ITE. However, the rapid development and revolution of ICT, especially in the internet sphere, has meant that traditional ITE, as well as training institutions, must undergo rapid changes in the structure and content of their training and the delivery methods of their courses, through strategic ICT pedagogical integration.

The conventional teaching which emphasised content taught through lectures in the transmission domain, interspersed with presentations, tutorials and learning activities designed to consolidate learning, is gradually giving way to more contemporary curricula. Curriculums that promote competency, skill development, knowledge construction and performance, and are concerned with how information is used, rather than with what information is (Oliver, 2003), have become the architects of

curriculum unpacking through ICT integration. It is important to note that the use of ICTs for knowledge construction goes beyond simply gathering information; it makes students and lecturers think critically about the information they have researched, and how to use it in meaningful ways.

Researching information and communication technology in education requires an understanding of the process of learning and teaching, not only in the formal education context, but also in various informal situations with the aim of comprehending the dynamics of the links and transfers between these settings that provide complex and challenging learning scenarios (Webb & Reynolds, 2012). Moreover, understanding how students' needs could be addressed in a dynamic technologically-rich environment, with changing pedagogical possibilities, demands that new professional development requirements for lecturers, policies restructured and systems be developed to accommodate the challenges. Webb and Reynolds, (2012) conducted a qualitative research to examine the theoretical advances in the use of new technologies (ICTs) in teacher education. Secondly, they examined issues on methods for researching technologies in formal and informal education, with the main focus on exploring pedagogy with ICT. They further explored the contributions of existing theoretical frameworks and models in researching pedagogy and pedagogical practices in a world where learning opportunities are diversifying as a result of technological developments. They came up with the notion of the development of new thinking about evaluation, reflection, assessment and feedback, and how these form part of the new pedagogy that can be facilitated through ICT. This work was built on the significant publications of Voogt and Knezek, (2008).

In Britain, Hennessy, et al., (2013) investigated qualitatively the influence of the use of digital technology on already familiar classroom activities in mathematics and science (more quickly, reliably, broadly, productively and interactively) and how this use may shape these activities. They reported evidence of 'pedagogical evolution', as the teacher's role develops to encompass mediating the process of ICT-supported learning. However, Hennessy, et al., (2013) maintained that the learning aims and values of these subject cultures seem to remain intact. In this context, ICT integration was taken to mean the use of technologies in teaching and learning as well as in pedagogy.

Similarly, in a quantitative study conducted by Sang, Valcke, van Braak, and Tondeur, (2010) in Belgium, on student teachers' thinking processes and ICT integration on prospective teaching behaviours with educational technology, they reported on the role of constructivism in integration. They emphasised that ICT integration is influenced by the student teachers' constructivist teaching beliefs, teaching self-efficacy, and attitudes to computers.

In these perspectives, ICT integration has to do with the use of technologies, pedagogy and the learning environment.

To integrate ICTs in education, in order to obtain the maximum benefits and to realise its full potential, ITE must be reformed to effectively equip student teachers with the knowledge, attitudes and skills that are needed to succeed and thrive in the digital knowledge bound environment. The teacher education system needs to take full cognizance of the ICT input in making this innovative process real. However, there is a need to develop technology-savvy lecturers who, through a healthy blending of the culture of traditional pedagogy, together with ultra-modern ICT inputs, are willing and able to prepare students for the 21<sup>st</sup> century, and are able to deal with all facets of the digital environment (Rastogi & Malhotra, 2013).

### **2.2.5 Perceptions of ICT integration in initial teacher education**

Most lecturers (teacher trainers) perceive integration of technology in education at 'face' level, as consisting of basic computer training whose role is to contribute towards effective and efficient teaching and learning to advance the quality of curriculum delivery (Enochsson & Rizza, 2009; Cross & Adam, 2007).

However, to connect to the students' world (digital generation), one of the important components that the teaching and learning medium has to employ is integrating ICTs in the curriculum or subject content delivery, in order to bridge that gap between conceptual development and conceptual learning. Many articles suggest that integrating technology in education supports learning, either directly (subject matter delivery), or indirectly, through making administration, communication or management easier (Chai, Koh & Tsai, 2010; Enochsson & Rizza, 2009; Barolli & Servrani, 2009; Gee, 2005) therefore, basic technology training becomes essential. Teacher trainers might be skilful when it comes to using technology, but there is no

guarantee that they will be able to use it to its full potential, or know what it means to teach through it, or with it (Bètrancourt cited in Enochsson & Rizza, 2009; Sardone & Devlin-Scherer, 2008).

Further, it is important to understand that to be able to integrate ICTs in teacher training institutions; the lecturers need to feel confident in using ICTs themselves, which is not always the case (Judge & O'Bannon, 2008; Whittier & Lara, 2006). Their findings revealed that lecturers reported lack of time as a reason for not being up-to-date in the field of technology, together with lack of access to equipment. The lecturers further expressed the need for training and trainers who finished the programme to provide evidence of ICT implementation in their courses, as well as extensive technical support and collaboration with colleagues.

It is also evident, from research, that pedagogical designs that justify the how, why and which ICT used influence lecturers effectiveness in teaching and learning (Wang & Woo, 2007). Therefore, ITE lecturers who are the cornerstone in promoting the efficient, creative and innovative use of ICT for conceptual understanding and for imparting skills to students for use at the work environment should be well equipped with the necessary skills to effectively use the tools in the teaching process.

### **2.2.6 Global views on ICT integration in teaching and learning**

Appropriate use of ICTs can raise educational quality and connect learning to real-life situations (Fu, 2013). At the same time they create the opportunity to raise the expectations of students, so that they seek knowledge which differs from the traditional approaches (Lowther, et al., 2008; Weert & Tatnall, 2005). To successfully achieve this departure, skill in using ICTs is essentially an indispensable prerequisite (Fu, 2013). Castro Sánchez, and Alemàn, (2011) argue that ICTs provide more educational affordance and possibilities, and with multiple resources via the internet, knowledge could be acquired through video clips, audio sound, and visual presentations, and contribute towards transforming the teaching and learning environment into a more student-centred space. Moreover, it gives students confidence, through the authority of the lecturers, to make decisions and plans, and to consult on issues relevant to their academic development (Lu, Hou & Huang, 2010). O'Hagan, cited in Jafter, Ng'ambi, and Czerniewiec, (2007), suggests that

ICTs in education can be used to present and provide content, assess students learning, provide feedback, scaffold student learning and promote peer-to-peer collaborative learning. A gradual departure from the static, text- or print based educational technologies occurs, which recognises the relevance of varied learning pathways and many different articulations of knowledge, which encourage students to explore and discover.

However, Cuban (2001) in his research found no clear and substantial evidence of students increasing their academic achievements as a result of using ICTs.

ICT integration contributes towards conceptual understanding through efficient and effective digital information surfing, in addition to knowledge construction, problem solving and skill development (Brush, Glazewski & Hew, 2008). Furthermore, ICTs generate a creative and innovative learning environment for new understanding through different learning inquiries (Chai, Koh & Tsai, 2010). ICTs enable students to communicate, share, and work collaboratively anywhere and anytime (Koc, 2005), and contribute immensely towards a constructive learning approach for the development of critical, higher-order thinking skills (McMahon, Forde & Martin, 2011). Seemingly they also improve teaching and learning quality, considering the autonomy, capability and creativity they provide (Lowther, et al., 2008).

Furthermore, Gee, (2005) posits that ICTs allow lecturers (teacher trainers) to organise their own material more efficiently, hence providing more diversity in curriculum delivery, than in the traditional setting, through quality teaching which enriches students learning skills. Also, they assist lecturers to optimise creativity, to the extent of discovery with multimedia tools and craft materials, using different sources, such as games. Once lecturers build confidence in students to use ICT, they develop the capability to apply and transfer knowledge with technology in their learning process. At the same time, it develops students' creative learning capability through students' manipulation of existing information, and the creation of real-world products, rather than the regurgitation of information received.

The role of motivation as an integral part of ICT integration in teaching and learning has been studied intensively (Mayer, 2011). Indications were that motivation

instigates action, fosters persistence and intensity, and encourages cognitive processing for making sense of learning material. In addition, motivation plays a central role in academic learning (Anderman & Dawson, 2011). In both cases, the theories informing conceptual drive were the cognitive-motivational theories, including the attribution theory (Graham & Williams, 2009) and the self-efficacy theory (Schunk & Pajares, 2009).

Presenting similar argument for the motivational value of ICT, Gee (2011) claims that technology-supported learning environment affords features that promote motivation, such as challenge, curiosity, control, fantasy, competition, cooperation, collaboration and recognition. However, Clark, Yates, Early, & Mouton (2010) indicated that increased motivational demand on students in e-learning environments may increase drop-out rates, and contribute to less focus during learning.

It is interesting to note that the methodological frameworks employed by the respective researchers were similar, and recommended future research to involve methodological refinements, such as the addition of a comparison group, and empirical refinement aimed at understanding the link between the motivation and the achievement of learning outcomes (Mayer, 2011).

Many researchers also found that ICT-enhanced learning increased students' engagement with learning, thus learn best with conceptual understanding as they learn (active learning). Whenever appropriate, in-depth work on real-life problems made learning more relevant, thereby minimising memorisation-based or rote learning. In the same vein, ICTs promote a thematic, integrative approach to teaching and learning, thus eliminating the artificial separation between the different disciplines, and between theory and practice that characterises the traditional learning and teaching environments. ICT integration in curriculum delivery encourages interaction and cooperation among students, peers, academics and experts, regardless of distance, and promotes learning with people from diverse cultures, thereby enhancing team and communicative skills, as well as global awareness.

Contrasting with the positive impacts mentioned above were challenges. Research

showed those lecturers' (teacher trainers') limited use of ICT (mainly for preparing teaching and learning materials and for tests) did not promote critical thinking (Yildirim, 2007). Similarly, Palak and Walls (2009) found that educators mainly use technology to support their existing teaching approaches, and to reinforce their pedagogy, instead of transforming or showing pedagogical change. Further, ITE preparation provides limited ICT knowledge to support technology-based instruction and sufficient methods for integrating technology in classroom practice (Brush, Glazewski & Hew, 2008). Addressing this deficiency calls for more improved, and well-structured curricula, with ICT training and skill development given prominence, and lecturers should be encouraged in technology curricula delivery (Supon & Ruffini, 2009). Instead of providing education theories, ICT researchers should document illustrations of how lecturers accomplish meaningful and effective technology integration to meet their pedagogical goals (Chen, 2008). However, this may be difficult to realise since current educational trends focus on improving examination performance, which shifts focus away from using ICTs, to engage students in higher-order thinking activities (Goklas, Yildirim & Yildirim, 2009).

Infrastructural and technical support, including administrative impacts, is also factors that contribute towards the effective integration of ICTs in curriculum presentation. Appropriate administrative support for the effective use of ICTs is lacking (Lim, 2007) and does not encourage students' skill development to obtain the full benefits of ICTs.

Lim (2007) eluded to the fact that availability and proper use of ICT resources, amongst others, could facilitate students' critical thinking capability. Thus, technology availability and general support are relevant to technology integration. The higher the support structure, and technology availability, the higher the technology integration by lecturers and students.

### **2.2.7. Integrating ICT for varied learning experiences**

Integrating ICT in education could contribute to the strive for education to emerge from its disciplinary narrowness, and to create a fashioning climate of values that encourages questioning, exploration, problem-solving, decision making, and group co-operation (Jung, 2005). Furthermore, Jung (2005) claims that ICT generates

students' and lecturers' interest in learning when they should make use of varied unique resources, such as animation and simulation software, for conceptual development and understanding. Therefore, using ICTs to support and design effective learning environments offers the opportunity to identify useful learning materials from various sources which contribute to constructive learning experiences.

Making the appropriate choice of an ICT resource for a specific task, with clear understanding, knowing the strengths and weaknesses of the technology resource, and communicating effectively with a variety of audiences, is a holistic experience that could change the teaching and learning landscape for teacher trainers and student teachers. Further, the ability to use ICT not only to find and scrutinize relevant appropriate electronic information sources, but also the capability to investigate technology-based options for lifelong learning using productivity tools, communication tools and research skills (Jung, 2005) are also varied learning experiences that enhance holistic learning.

The expected standard of competency in ICT of ITE students at the exit level of the programme is the ability to develop these skills, demonstrate knowledge of using the skills and successfully engage them in practice in a contemporary society.

### **2.2.8 ICT capability and adeptness of lecturers and students**

The reluctance of student teachers, as well as lecturers, to use ICT for pedagogical practice, due to lack of operational skills (Twindle in Enochsson & Rizza, 2009) has been an issue of great concern and requires special courses to raise their technical competencies. In addition, Parker, Carlson and Naim (2007) suggest that students need time to develop their knowledge and hands-on experience. However, with so much for them to do in terms of their content modules, very little time is at their disposal. Furthermore, Karsenti, Raby and Villeneuve, cited in Enochsson & Rizza, 2009 suggest that supervised and sustained training is required for comfortable and effective implementation of ICT pedagogy. Also, teacher education must set and monitor requirements for ICT competency for students to achieve, before exiting the degree or programme. Supporting this view, Kirschner and Davies, cited in Enochsson & Rizza, (2009) proposed that it is important to work with technology

throughout teacher education so that it becomes a natural part of teaching. However, Bètrancourt, in Enochsson & Rizza, 2009 in a qualitative study, contends that there is no correlation between student teachers' technological competencies and their pedagogical use of ICT. Bètrancourt (ibid) further claims that lecturers may not compose a constructivist view of ICT and because of this cannot always see how it could fit into their curriculum delivery.

It is worth acknowledging that technology by itself is not likely to improve or generate effective teaching practices (Tee & Lee, 2011) or lead to change; rather it is the way in which lecturers integrate technology that has the potential to bring change in the teacher education process. Thus, lecturers must develop a positive attitude and belief, and feel that ICT is a valuable educational tool to boost the teaching and learning process (Rastogi & Malhotra, 2013). It becomes incumbent upon them to make a commitment to improve their ICT skills, and in turn, to integrate ICT into their classroom teaching activities.

In order to integrate ICT more effectively in the educational, as well as the development environment, it may be worth understanding lecturers' present levels of ICT skills as well as their attitudes to the ICT–pedagogy integration syndrome, to improve their ICT skills, thereby making the teaching-learning and development process more attainable.

Rastogi and Malhotra, (2013) examined teachers' attitudes towards ICT, their levels of competency and skills, experiences with ICT, and their current use of ICT resources in educational practices. They (Rastogi and Malhotra, 2013) observed that ICT is not well received by teachers, including lecturers, as they consider it an extra burden. Rastogi and Malhotra, (2013) further commented that the mismatch between teachers' culture of techno-centric mindedness and pedagogic culture underpinned by beliefs, often results in the alienation of technology use.

Research also suggests that lecturers' beliefs are key in determining the integration of ICTs in curriculum delivery (Gao, Choy, Wong & Wu, 2009; So & Kim, Chere-Masopha & Bennett, Sipila, Tondeur, Cooper & Newhouse, all cited in Tay, et al., 2012).

### **2.2.9 Integrating ICT in mathematics education**

Hennessey, et al., (2013) examined the pedagogical ideas behind mathematics teachers' use of ICT and found that teachers use both behaviourist and constructivist philosophies as complementary to their teaching. They identified the combination as unhelpful, which thus led to no change in students' approach to learning mathematics. Furthermore, the influence of technology as a teaching and learning tool was not recognizable. The Becta (2003) report suggests that teachers using technology in teaching mathematics use certain aspects of ICT (such as 'tinkering' where students use ICT to explore and manipulate results) as problematic causing teachers to reconsider their practice and develop their pedagogical thinking.

Jarrett, cited in Becta (2003), researched two groups of students being taught mathematics with ICT in two separate learning environments (behaviourist and constructivist) and found that students in the constructivist environment used ICT to explore and reach understanding of mathematical concepts, and out-performed those in the behaviourist classroom where ICT was used primarily as a presentational tool for pre-packaged material delivery. This implies that ICT used in teaching and learning mathematics has the potential to improve learner performance. However, it depends on the pedagogical orientation of its use. Jarrett (cited in Becta (2003), further suggests that for effective use of ICT in mathematics the most appropriate hardware and software (identification of the appropriate productivity tool) and support is available. There must also be appropriate mediation between students and the computer, so that the teacher provides support to enable students to become active learners. Teachers, on the other hand, must be aware of the range of software available and select programmes to support particular learning skills.

Hennessey, et al., (2013) also showed that ICT integrated in the mathematics classroom improves collaboration between students, increases focus on strategies and interpretation, gives fast and accurate feedback and increases motivation amongst students. Hennessey, et al., (2013) further claim that teachers can maximise the potential of ICT in mathematics teaching by using technology tools in working towards learning objectives, and developing knowledge of the multimedia software available.

### **2.2.10 Integrating ICT in science and technology education**

When making sense of scientific ideas, students need opportunities to work independently and collaboratively. Teachers, on the other hand, need sufficient scientific background knowledge to design learning experiences and tasks that support learning with ICT. Otrell-Cass, Khoo, and Cowie (2011) contend that digital tools (new technologies) that support visual meaning-making in science support students' learning. ICT such as videos, animation, images and models from the internet, visual thinking software and digital microscopes are vehicles for representations, reflections and argumentation (Otrell-Cass, et al., 2011). These tools become invested with meaning when they are used and adapted to become part of student and teacher reasoning.

Secondly, ICT can be used to promote student independence, motivation and engagement. Research indicates that when ICT is effectively used, students are usually motivated and enthused, particularly when they use digital tools independently to solve problems. It is interesting to mention that, if problems are contextualised, they generate interest that requires an authentic use of digital tools to solve them (Otrell-Cass, et al., 2011). According to Ferguson, Whitelock & Littleton (2010), ICTs that support tasks with more than one possible solution and opportunities to illustrate and manipulate findings, provide a rich source for students to become more active and absorbed in the learning process. However, lecturers' pedagogy, knowledge and familiarity with technology play an important role in the effective use of ICT to develop students' conceptual understanding, and to benefit from digital tools to deepen their thinking and ICT proficiency.

It is worth noting that, how teachers prepare for classroom instruction in science and technology teaching depends on their knowledge in addition to being aware of how different digital tools promote learning, expand learning experiences, help students relate science to their own experiences, enable data-collection, enhance self-management and promote communication of scientific ideas (Cowie, Jones & Harlow, 2006).

ICTs, if successfully integrated in teaching and learning science and technology education, will create interesting learning environments where students will not only

apply skills and knowledge but will also be motivated to go beyond simply finding “right answers”. It is well understood that at times science can be hard to comprehend because not every phenomenon is clearly observable, hence visual ICTs have the potential to unveil the hidden components of such phenomena through manipulation (Ferguson, et al. 2010). For the potential of ICT to be maximised in science and technology education, the learning environment must operate in a contemporary atmosphere with a constructivist approach.

In the follow-up section, the researcher discusses the pedagogical integration of ICT and its role in teaching and learning.

## **2.3 THE ROLE OF ICTs IN THE TEACHING AND LEARNING PROCESS**

ICTs do play a number of roles in education. These include acting as a catalyst for rethinking teaching practice (Flecknoe, 2002; McCormick & Scrimshaw, 2001); developing the kind of graduates and citizens required in our information society (Department of Education, 2001); improving educational outcomes and enhancing and improving the quality of teaching and learning (Garrison & Anderson, 2003). Notwithstanding the above, ICTs also expand educational opportunities and increase efficiency, enhance the quality of learning, enrich the quality of teaching and facilitate the development of skills.

For the successful use of ICTs in schools then, the agents of change in the classroom (teachers) have to be equipped with the necessary skills and knowledge. This is where the role of lecturers and ITEs in general become essential and inevitable.

### **2.3.1 Utilisation of ICTs in teaching and learning**

Understanding ICT use at the level of pedagogical engagement provides an insight into its relationship with teaching and learning (Czerniewicz & Brown, 2005). Pedagogy is about process and content, as well as context. Pedagogy is also about the various forms of interaction between teacher, student(s) and the knowledge domain. It requires consideration of interrelations between teaching approaches, learning experiences, the nature of context under discussion and the knowledge

created. This challenge was taken up by researchers who developed theories linking teaching and learning interactions to purpose, types of ICT use, categorised types of ICT forms, and explicitly linked them to particular teaching and learning events.

Lim (2002) has specifically proposed using activity theory to examine elements of ICT use within academic programmes but does not offer an explicit way of describing the kinds of ICT used for teaching and learning. On the other hand, Laurillard (2002) developed the conversational framework which classifies different types of ICTs in relation to key teaching, and learning events in a way that makes it possible to link them to specific teaching strategies and learning experiences. Laurillard (2002) further argued that academic learning requires a variety of learning activities to develop an understanding of knowledge and mastery of skills in the subject. The researcher believes that the way lecturer and student roles intersect is through engagements and activities to develop the required skills and conceptual understanding.

Czerniewicz and Brown, (2005) investigated ICTs as part of teaching and learning. More precisely, how are ICTs used to support different teaching and learning events? What kinds of activities are most supported by, or used in conjunction with ICTs? How are ICTs used across the curriculum? They found that ICTs are frequently used to support discovery, which is congruent with research development and access to disciplinary content. A close look at their findings reveals that computers are mainly used for the writing of assignments, with very little other productive activity reported. Their use for communicative and adaptive activities for teaching and learning is low, suggesting that the unique features of ICTs are not the main drivers of their use for teaching and learning.

### **2.3.2 Challenges using ICTs in teaching and learning**

The adoption of mass higher education for all citizenry resulted in the population growth and explosion of class sizes, which is an endemic feature of many courses at higher education institutions (Jaffer, Ng'ambi & Czerniewicz, 2007), which poses a challenge across most HEIs in South Africa. Large class sizes make it difficult for teacher trainers to employ interactive teaching strategies, or to gain insight into the difficulties experienced by students (Nicol & Boyle, 2003). Though certain

educational technologies, if well understood and appropriately employed, could provide useful opportunities to minimise the effect of large class sizes, the curriculum has to be transformed and lecturers have to transform their teaching practices.

Further, faced with tremendous pressure from the government to meet the needs of social transformation in education, increasing the representation of Black South Africans and women in tertiary education (Jaffer, et al. (2007), many South African universities admit students who are poorly equipped with ICT knowledge and skills. This poses another challenge to lecturers who wish to deliver the curriculum using educational technologies.

Jaffer et al. (2007) also claim that the challenge for ITE lecturers is their ability and capability in identifying and conceptualizing ways that educational technology can usefully contribute to student learning experiences, curriculum and pedagogical design.

These challenges amongst others, together with other limiting factors as discussed next, affect the effective integration of ICTs in the classroom.

## **2.4 EPISTEMOLOGY, ONTOLOGY AND ICT INTEGRATION**

“Epistemology is the systematic consideration, in philosophy and elsewhere, of knowing: when knowledge is valid, what counts as truth, and so on” (Packer & Goicoechea, 2000:11). Further, Packer & Goicoechea, (2000), succinctly stated that “Ontology is the consideration of being: what is, what exists, what it means for something - or somebody - to be”. Gruber (1993), on the other hand explained that ontology specifies the most fundamental categories of existence, the elementary structures out of which the world is made. However, Gruber (1993) pointed out that in information technology, ontology can be seen as a specification of a conceptualisation in context of artificial intelligence and knowledge sharing. This means that ontology is a description of the concepts and relationships that can exist for an agent or a community of agents (ICT, student and lecturer) and consistent with the usage of ontology as a set-of-concept-definitions. This description informed the

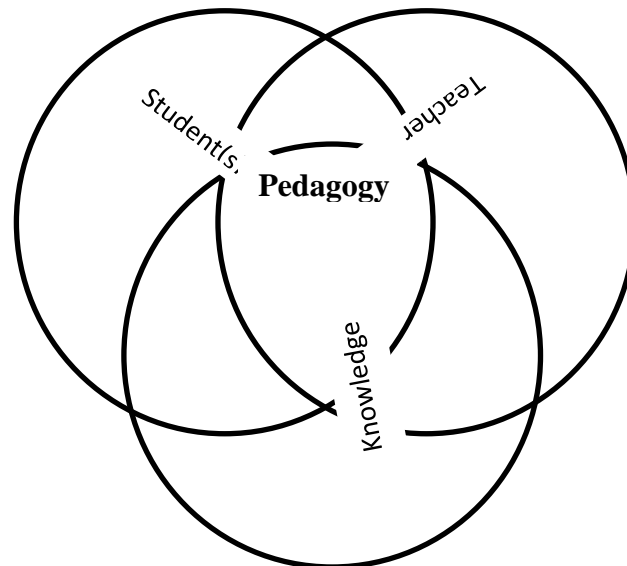
basis for analysing the underlying epistemologies and ontological assumptions of the participants.

Epistemologically, my view of knowledge settled on a sociocultural perspective proposed in Hodgkinson-Williams (2006), which emphasises the characteristics of social participation, relationships between the novice and the expert, newcomer and old timer, the setting of the activity, and historical change.

The socio-relationship and partnership between the novice and expert determines how ICTs are used within a mode of operation. Either as representational tools, characterised by the mastery of computer skills where the role of the student is to absorb the material defined by the lecturer and outcomes judged by the student's ability to reproduce the material, or as cognitive tools which greatly depend on the mindful engagement of the user. In this case, the students and lecturers in tasks afforded by these tools focus on the individual and his/her relationship with ICT (Ross, Morrison & Lowther, 2010). This is what Salomon, Perkins and Globerson (1996) refer to as an "intellectual partnership". Similarly, mediational tools which the researcher refers to as "collaborative e-learning" occur within a social environment that provides the user with a resource of other users each with their own knowledge, experience and expertise, with whom to share ideas, negotiate meaning and work towards shared understanding (Hodgkinson-Williams, 2006). Lastly, (to mention just a few) transformational tools whereby users have access to, and are fully exposed to, both multiple and competing interpretations of the "world" which transforms the approach to teaching and learning.

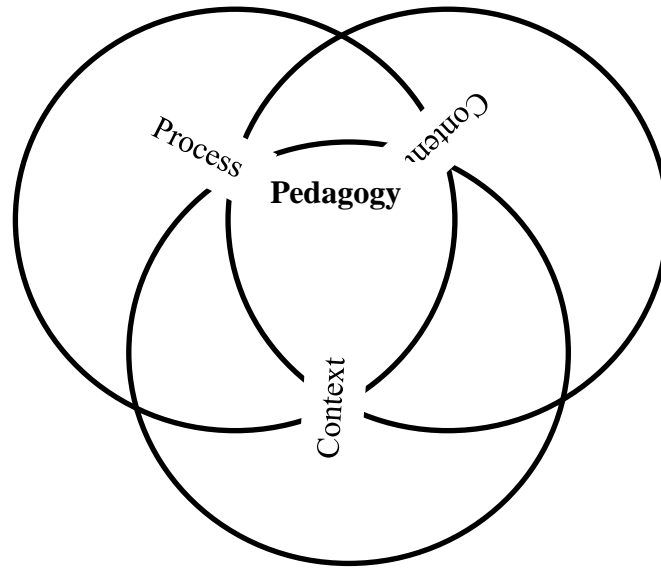
## 2.5 PEDAGOGY AND ICT INTEGRATION

Pedagogy is about the various forms of interaction between three agents, teacher, student(s) and the knowledge domain (Garrison & Anderson, 2003). Their view is illustrated conceptually in figure 2.3.



**Figure 2.3: Pedagogy as an interaction between teacher, student and knowledge**

Pedagogy is not only about process and content, but also about context (Czerniewicz, et al., 2005) inter-relations between teaching approaches, learning experiences, the nature of the content and knowledge being created. All of which featured dominantly in many discussions evolving around technology and pedagogy (Bernstein cited in Czerniewicz, et al., 2005). The conceptual display of this integrated approach is shown in figure 2.4.



**Figure 2.4: Pedagogy as an interaction between process, content and context**

Notwithstanding the above, pedagogical integration of technology into teaching and learning is also dependent on a number of other factors, which include lecturers' confidence, readiness, capability, knowledge and the ability to assess the values of ICTs in curriculum delivery, and the lack of skills to efficiently and successfully use ICT tools and resources (Chigona & Chigona, 2010).

### **2.5.1 ICT- pedagogical integration**

Preparing ITE students (student teachers) to use ICT in a pedagogical way in future practice has been a topic of a lot of research (Enochsson & Rizza, 2009; McGregory cited in Enochsson & Rizza, 2009; Moeini, 2008) and others in similar studies illuminate the importance of teacher trainers' understanding, not only of how to use ICTs, but also of general pedagogical knowledge related to ICTs, as well as understanding how technology impacts the learning process (Enochsson & Rizza, 2009). Similarly, Lavonen, Lattu, Juuti & Meisalo (2006) in their research on pedagogical integration of ICTs by lecturers (teacher trainers) argue that lack of pedagogical skills is a contributing factor towards pedagogical integration, though they commented that it does not mean less competency within the field (ICT) but can be an indication of knowledge of diversified ways of using ICTs.

Drent & Meelissen (2008) investigated factors that obstruct or stimulate lecturers'

use of ICT innovatively in The Netherlands, who by using questionnaires found that lecturers of ITE who use ICTs innovatively in their teaching and learning processes are interested in their own professional development, keep extensive contacts with colleagues and experts in the area of ICT, see and experience the advantages of the innovative use of ICTs in education, and describe the pedagogical approach as student-oriented. For student teachers to benefit and develop ICT skills, calls for teacher trainers' pedagogical transformation from teacher-centred to student-centred oriented curriculum delivery.

### **2.5.2 Pedagogical transformation**

Technology and pedagogy are converging on the learning landscape with a possible collision with cultural and traditional dispositions which dominate the current approach of curriculum delivery, caused by the digital difference between students and lecturers. An indication that many academics, including teacher trainers, have not fully embraced new trends in the higher education curriculum, as well as ITE curriculum delivery, is an advocate for pedagogical transformation.

Discussion in several articles on pedagogical integration of ICT in ITE curriculum delivery points to pedagogical transformation or pedagogical change of teacher trainers, a change from 'teacher-centeredness' or the traditional approach of lecturing, to that of a student-oriented approach or constructivism framework. The traditional way of teaching in this context refers to a system where the teacher is at the centre of the learning process, and gives lectures and expects the student to absorb and to regurgitate and reproduce, while the constructivist frame advocates that students be at the centre of learning, actively constructing their own knowledge and thus taking responsibility for their learning. Although some authors claim that a constructivist view is necessary for the integration of technology in the classroom, there is no empirical evidence presented in those articles (Enochsson & Rizza, 2009).

In order to understand the demands of pedagogical transformation in the present digital environment, it is imperative to compare the traditional pedagogical system to the current emerging pedagogical trend. The table below, as identified by Thijs, et al., cited in Tinio (2012) is a comparison of the two pedagogies within identified

frames.

<b>Aspect</b>	<b>Traditional Pedagogy</b>	<b>Emerging Pedagogy</b>
Active	Activities are prescribed by the teacher Whole class instruction Activities are monotonous Pace set according to programme	Learners determine activities  Small groups oriented Variation in activities Learners determine pace
Collaborative	Individualistic Homogenous groups  Self-supporting	Team work promoted Heterogeneous groups thus cultural integration supporting each other
Creative	Regurgitated/Reproductive learning Apply established solutions to problems	Productive learning attained Find new and varied solutions to problems
Integrative	No link between theory and practice Separate subjects Discipline-based Individual teacher	Integrated theory and practice dominant Integration of subjects Thematic Collaborative / team teaching
Evaluative	Teacher directed, controlled and centred Summative	Student-centred  Diagnostic

**Table 2.3: Comparing traditional pedagogy and emerging pedagogy**

The table presents emerging pedagogy with the new challenges and pedagogical transformation dilemmas for lecturers, including teacher trainers and other academics of tertiary institutions. The paradigmatic shift in the 21<sup>st</sup> century, where

students demand more in terms of digital disposition places lecturers and academics alike in digital predicament. This paradigmatic shift furthermore raises concerns regarding the exercise of the authority of the lecturer in the classroom, from being a teacher-centric curriculum deliverer to adopting a student-centred approach allowing for global learning and teaching- a reality of pedagogical transformation.

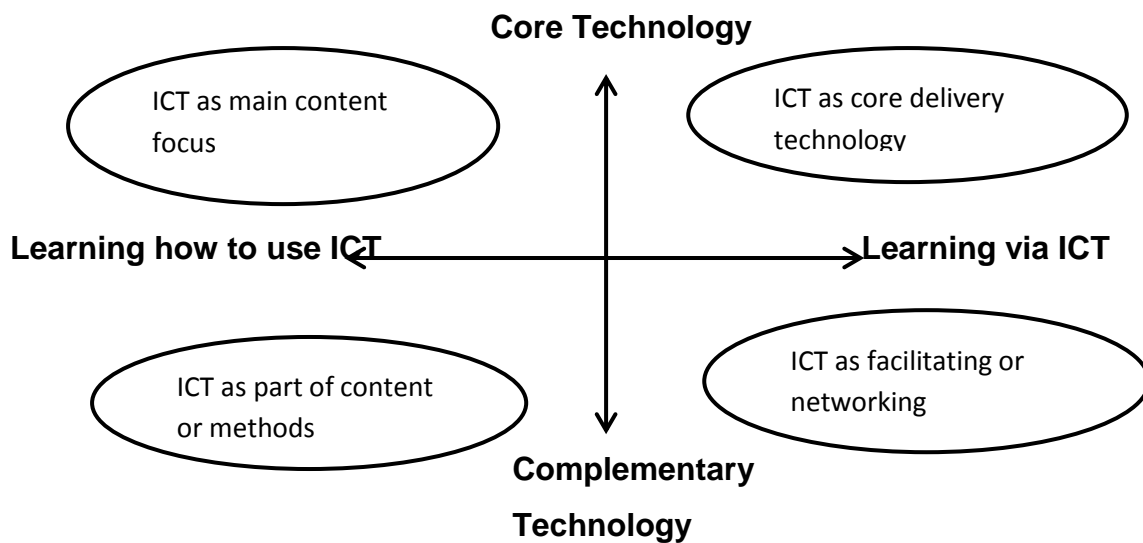
To set minds at rest, Larson (2008) postulated a return to a more traditional approach to teaching, despite the increased technology used, illustrating the use of interactive whiteboard (IWB) and power point presentations. Voogt, cited in Law, Pelgrum, & Plomp, (2008) found a persistent traditional dimension in the distribution of responsibilities between teacher and student when analysing data from SITE 2006, though regular engagement with ICT seems to contribute to a change in practice in a constructivist paradigm. It is apparent that the majority of the tools used in curriculum delivery are limited, such as presentation tools and information searching and evaluation resources which support traditional transfer pedagogy.

To promote innovative pedagogical use of ICT in ITE classroom, lecturers' professional development is a necessity to influence student teachers during their training and support their future innovative use, as well as effective pedagogical integration. Shuldman (2004) concluded from research that the impact of ICT integration on students' learning will be negligible unless lecturers evolve towards a clear and comprehensive understanding of technology and its role in instruction, which is what, is expected from any instructional resource or tool. Therefore, pedagogical strategies of integrating ICTs, in instruction for effective quality teaching and learning, cannot be overlooked.

### **2.5.3 ICT- Integrated pedagogical strategies**

A well designed and coordinated teacher training programme is essential to meet the demands of today's teacher who wants to use ICTs effectively in teaching and learning (Jung, 2005). As such, strategic development of an ICT- pedagogical integration approach is required, not only to consolidate the use of technology and the new opportunities it creates, but to bring with it new implications and challenges indicating a need for a variety of approaches of integration and use of technology in ITE. Jung (2005) presented four approaches, as represented below and discussed

next.



**Figure 2.5: ICT pedagogical integration strategies (Adapted from Jung, 2005)**

These approaches Jung (2005:47-49) claims are category organizations for various teacher education efforts found in different countries, and discussed them as follows:

ICT as the main content focus of teacher education emphasises teacher training on how to use the resources in practice (classroom) and address issues, such as selecting appropriate tools (ICT) and supporting students in the use of these tools, using ICT to promote learning activities, and to develop new methods of facilitating and evaluating students' performance. It therefore focuses on basic ICT skills development, design skills and pedagogical strategies. However, Jung (2005:49) complained that basic ICT skill development, rather than the ICT-pedagogical integration has been a concern of teacher education.

ICT use as part of teaching methods integrates it (ICT) into teacher training and demonstrates how a variety of the tools are adopted as part of effective training methods to provide a more effective way of ICT-pedagogy integration in teacher education programmes. Seemingly, students use ICT to learn about ICT skills, and to develop ICT-integrated pedagogies through actively experiencing ICTs being used by lecturers (Jung, 2005). It is my contention that student teachers will efficiently integrate ICT in their practice if they

experience ICTs in their learning process. Further, to facilitate professional development of teacher trainers, develop students ICT skills, and promote ICT-pedagogy integration in teaching and learning, ICT-based environments that challenge and motivate the effective implementation and the use of ICT to support intellectual development and attainment, is required.

ICTs as facilitating or networking, explore the integration of ICT to facilitate some aspects of teacher education, with emphasis on the adoption of a variety of technology resources as part of effective curriculum delivery, while at the same time equipping student- teachers with the required skills to adequately use them in their practice. In this respect, the student-teachers are provided with illustrations of ICT-pedagogy integration through the sharing of practical ideas, and involvement and engagement in ICT integrated training.

ICTs as the core technology for delivering teacher training considers the use of ICTs as the major strategy for providing learning experiences in teacher education, with greater focus on the variety of ICT applications, and with little attention given to skill acquisition or development. In this approach, programmes are designed to train prospective teachers to become online course instructors and course developers.

Jung (2005) provided substantial literature on the practical implication of these approaches in different countries, but could not however, provide evidence of the workability of the approaches and how successful and sustainable they were, nor describe the environments provided for the implementation of these approaches. It is my firm belief that these approaches, if well explored and implemented, will increase collaboration and interaction amongst student-teachers, both locally and internationally.

Similarly, reviewing the approaches of teacher training programmes around the world, Khirwadkar (2006: 34-35) refined and merged them and proposed the following approaches:

“ICT skill development approaches – priority training offered to student-teachers to be skilled users of ICT with the provision of knowledge about

different software, hardware and their uses in an educational setting.

ICT pedagogy approach – the precept here is integrating ICT skills in content delivery with emphasis on student-centred dimensions of delivery, with adequate use of tools that foster attainment of learning outcomes.

Subject-specific approach requires embedding ICTs in subject content, using the resources to advance innovation and creativity to provide students with a practical understanding of what teaching and learning with ICTs looks like, in a variety of ways. In this perspective, ICT is not an ‘add on’, but an integral tool for subject content delivery.

Practice driven approach – the central phenomenon here is exposure to the use of ICT in practical aspects of teacher education, by using ICT and implementing it in fulfilling task requirements at different levels, as well as providing student-teachers the opportunity to assess and evaluate their ICT potential and capabilities”.

The author excellently outlined these approaches, but could not provide international or local evidence of successful and achievable outcomes of the implementation. This is a gap that could be explored to substantiate whether these approaches could advance the pedagogical integration of ICTs in teacher education curriculum delivery for quality education.

It is worth knowing that the successful integration of ICT in teaching and learning is a multifaceted issue encompassing other things, and thus requires a holistic approach. ICT integration in education involves lecturers changing their traditional ways of teaching, in addition to being more creative in adapting and customizing their teaching materials and strategies (Reid cited in Fu, 2013), with emphasis on collaborative learning, problem-based learning and a constructivist approach (Whelan, 2008). A view expressed by Palak and Walls (2009) and Tezci (2011), is that the desired effect of educational technology integration is attainable within a student-centric teaching and learning environment. This indicates that the implementation of ICT integration in education has to be done holistically, taking into

consideration all the contributing factors.

#### **2.5.4 Limiting factors to ICT- pedagogical integration**

Researchers and educationists used two different categories to classify the limiting factors to ICT integration, namely extrinsic and intrinsic barriers. Ertmer (2010) simplified extrinsic barriers as first-order, which include access, time, support, resources and training and intrinsic as second-order barriers citing attitudes, beliefs, practice and resistance. Similarly, Al-Alwani, cited in Bingimlas, (2009) perceived extrinsic barriers as pertaining to organisations rather than individuals, and intrinsic barriers as pertaining to teachers, administrators and individuals.

Another perspective presented in literature constructs the classification as teacher-level barriers and school-level barriers. Becta (2004) rates the barriers according to whether they relate to the individual (teacher-level barriers) such as lack of time, lack of confidence and resistance to change, or to the institution (school-level barriers) such as lack of effective training in solving technical problems, and lack of access to resources.

Similarly, Balanskat cited in Bingimlas, 2009) divided them into micro level barriers, including those related to teachers' attitudes and approach to ICT, and meso level barriers, including those related to the institutional context. However, he added a third category, classified as macro level barriers (system-level barriers), and including those related to the wider educational framework (Bingimlas, 2009).

Pelgrum (2001) presented perspectives relative to obstacles pertaining to two kinds of conditions: material and non-material conditions. Material conditions are cited as insufficient computers or copies of software, and non-material obstacles include teachers' lack of ICT knowledge and skills, the difficulty of integrating ICT in instruction, and insufficient time.

Keeping in mind the purpose of this project, which is to investigate ICT pedagogy integration, the discussion on barriers that follows is streamlined along a mixture of teacher-level and school-level barriers;

In ICT-pedagogy integration in teacher training; applying cases worldwide, Jung (2005) found that:

ICT basics are taught to teacher trainers (ITE lecturers) focusing on basic application and technical issues, with little emphasis on the pedagogical dimension.

The approach adopted in teaching educational technology still remains in the traditional paradigm and shows no evidence of how new technology can be used to support instructional creativity and innovation.

Technology input is not integrated in the curriculum courses; especially the methods of teaching the content courses and teacher trainers rarely employ ICT in curriculum delivery.

Time duration of ICT education related course is too short to develop knowledge and skills among lecturers, as well as students, to achieve critical thinking skills.

Many ITE institutions lack proper ICT infrastructural facilities, support, programmes for upgrades and ICT resource maintenance by the technical staff.

Jung (2005) contends that an effective integration of ICTs at ITE should place students in a position to integrate technology into their practice, as well as develop the art and skill of “webogogy” (making use of internet technology, exploring it, accessing information from it and using it in teaching and learning). However, Jung did not suggest solutions for the identified limitations.

Similarly, Fu (2013) cited researchers who identified some barriers, with suggested appropriate approaches to address them. Fu (2013) placed the barriers in two main perspectives: (i) lecturer and (ii) administrative and infrastructural, as discussed below:

A lack of lecturer collaboration and pedagogical support existed, as well as a lack of experience among cooperating lecturers. Ertmer & Otterbreit-

Leftwich, (2013), suggested that partnership support programmes that help lecturers share effective technology practices, skills knowledge and experiences, be embarked upon assiduously.

There was limited knowledge and experience of ICTs in the teaching context. Honan, Exley, Kervin, Simpson, & Wells, (2013), proposed that adequate freedom must be provided for lecturers to explore curriculum materials to encourage the implementation of ICTs in material development and delivery.

There was insufficient specific knowledge about technology and how to combine it with existing pedagogical content knowledge to support student learning. Hutchison & Reinking, (2011), advised that substantial, effective, timely and continuous professional development, including technical knowledge, be provided to improve on ICT skills to manage technology-enriched learning environments

Curriculum delivery is too result oriented, shifting focus away from using ICTs to engage students in higher-order thinking activities which, Yildirim (2007) suggested, has made institutional systems involved in teacher training, place emphasis on traditional content knowledge acquisition, limiting the use of technology in teaching for knowledge construction.

Hodgkinson-Williams, (2009) found that inadequate infrastructure in South African HEIs places enormous challenges on them to cope with the relentless technological developments, as well as the opportunities these technological developments bring about. She further claims that there seems to be no ICT policy framework regulating teaching and learning in Higher Education, and how this relates to research and community engagement, the two main key missions of HEIs.

On the other hand, Seidman (2004) highlighted that HEIs are experiencing a 'contestation of knowledge' in that the traditional ways of producing knowledge within single disciplines and institutions are being supplemented by knowledge generated within various applied contexts. Research shows that knowledge is created collaboratively within multidisciplinary and trans-disciplinary learning programmes,

when problem-specific directed (Department of Arts, Culture, Science & Technology [DACST], 1996).

Notwithstanding these enumerated issues, one huge test, that both lecturers and students face, is 'information overload' and this requires strategies to contain the quality and quantity of information available, especially via the internet and its pedagogical dilemmas.

Lim (2007) qualitatively examined effective and ineffective ICT integration in teaching and learning, and found that the availability of ICT resources, the establishment of disciplinary and education principles supported by policy, as well as procedures and the involvement of all role players, are crucial in the establishment of a well-managed ICT-integrated teaching and learning environment. Thus, Fu (2013) stated that technology availability and overall support are important to technology integration. The greater the support structure, the higher the technology integration efforts made by the students and the lecturers.

Research by Gomes (2005, cited in Bingimlas, 2009) relating to science education, concluded that lack of training in digital literacy, lack of pedagogic and didactic training on how to use ICTs in the classroom, and lack of training concerning the use of technologies in science specific areas, were obstacles to using new technologies in classroom practice. Some Saudi Arabian studies also reveal similar findings (Alhamd, et al., 2004, cited in Bingimlas, 2009).

Providing pedagogical training for lecturers, rather than simply training them to use ICT tools, is an important issue (Becta, 2004). Conceptualising this opinion, Cox, Preston, and Cox (1999) argue that for lecturers to be convinced of, and appreciate, the value of using ICT in curriculum delivery, their professional development should focus on pedagogical issues as well.

Research conducted on lecturers' beliefs about the use of computer technology and the effectiveness of professional development programmes (Serhan, 2009, Chai, Koh & Tsai, 2010) revealed that direct instruction on the use of technological tools and resources, through a technology enhancement lesson approach (incorporating pedagogy), developed and aided teachers on how to employ technology to enhance

quality teaching and student learning. Similarly, Vannatta and Beyerbach (2000), in their qualitative exploration, found that simply teaching basic ICT skills is inadequate if lecturers are to constructively integrate technology into their instruction process. Furthermore, Vannatta and Beyerbach (2000) suggest that more emphasis should be placed on advanced skills in ITE programmes, in order to provide student-teachers with authentic opportunities to experience and develop technology-integrated oriented lessons. These findings suggest that pedagogical integration of ICTs in teacher professional development programmes equips teachers, teacher trainers and lecturers to effectively and confidently adopt educational technologies in their curriculum disposition

### **2.5.5 Sceptic's views on ICT integration in teaching and learning**

Many researchers and published materials argue strongly about the positive contributions ICTs have made, and continue to make, in advancing learning. However, the views of a small but significant body of digital sceptics cannot be ignored.

Oppenheimer (2003) asserts that there is no good evidence that most uses of ICTs significantly improve teaching and learning. He contends that tools come and tools go, hence teaching children tools confines their knowledge to these tools and hence limits their future. In view of this the researcher thinks it is important to use these tools to develop skills and knowledge, and build understanding of content and context.

Postman (1995) also argues that while ICT might provide gains, it also involves losses and comes with challenges. He claims that in the past, when technology has had positive effects, it has also carried with it disadvantages. A new technology sometimes creates more than it destroys, but at times destroys more than it creates, and it is never one-sided. The abuse of technology in modern times seems to confirm the sceptics' fear of technology, which has now engulfed students.

Korte and Husing (cited in Oldfield, 2010), found, through an empirical survey of European teachers, that using ICTs in their classroom practice had no significant learning benefits, though argued that this scepticism seems to have little relation to a

country's ICT profile. In a similar research, Becta (2008, p. 45) discovered teachers' positivity about the possible contribution of ICTs was moderate, as they became "rather ambivalent and sometimes doubtful" about "specific current advantages".

Similarly, Bates (cited in Van der Merwe & Mouton, 2005) cautions that the integration of ICTs, without a well-defined strategy and changes in teaching and learning practice will only add costs to the system. He further argues that major structural and organisational changes will have to take place for technological change to be effective. "New technologies are likely to remain marginal, despite high levels of capital investment, and will merely add costs to the system if we do not at the same time deal with structural changes in our institutions and, in particular, if we do not make fundamental changes to the way we organise teaching" (Bates, 2000, p. 210 cited in Van der Merwe & Mouton, 2005). These views, as expressed by the sceptics on the integration of ICTs in curriculum delivery, have in many ways contributed towards the transformation of ICT integration strategies to address the 21<sup>st</sup> century technology implementation needs.

## **2.6 THEORETICAL FRAMEWORK**

The two learning theories that underpin the integration of ICT in teaching and learning are Behaviourist and Constructivist. Although many authors claim that a constructivist view is necessary for the integration of technology in the classroom, there is no empirical evidence presented in the materials engaged with. Hence the researcher will differ from that view, but believe that both views are relevant. However, the extent of integration differs in each case, and also contributes to the knowledge transfer model. In the discussion below the researcher presents a brief overview of the theories and then relates them to their ICT integration potential in teaching and learning.

### **2.6.1 The Behaviourist learning theory**

Behaviourists believe that there are two conditions that contribute to learning. These are classical conditioning and operant or instrumental conditioning. Classical conditioning is a type of learning based on the association of a stimulus that does not ordinarily elicit a particular response (Papalia, Fieldman, & Olds, 2007), with

association as the key element. Hence, if two stimuli are repeatedly experienced together they become associated. Behaviourists believe that every observable environmental event has the potential to exert control over behavioural response. They contend that a stimulus can produce response without any learning (unconditioned stimulus) and the response is unconditioned (inborn reaction). Further, a repeated stimulus (conditioned stimulus) produces a conditioned response (Papalia, Fieldman, & Olds, 2007).

With operant conditioning, learning occurs when the consequences of behaviour lead to changes in behaviour. This implies that behaviour that brings about a satisfying effect is apt to be performed again (reinforced), whereas behaviour that brings about a negative effect, such as punishment, is apt to be suppressed (Morris & Maisto, 2001).

According to Morris and Maisto, (2001) for stimulus to be effective it must have reinforcement schedules, either fixed-ratio (periodic repetition) variable-ratio (number of responses needed to gain the reinforcement is not constant), fixed-interval (behaviour reinforced after some time no matter how often it occurs) and variable-interval schedule (based on time passing, but the time period keeps changing).

The discussion therefore shows that this theory underpins the traditional way of teaching, learning and knowledge transfer, which is basically teacher oriented. Thus, the teacher-centred transmission model is based on the assumption that learning involves the accumulation of a particular set of facts and that teaching involves transmission of facts and skills by an expert.

The implication of this theory in the integration of ICT in teaching and learning will be discussed later.

### **2.6.2 Social and Cognitive Constructivism**

Social or the socio-cultural constructivist theory of learning, propounded by Vygotsky (1978) provided much impetus to drive the study. According to Vygotsky (1978), children's higher mental functions are developed through interaction with more

cognitively capable entities, such as persons or a computer. This implies that social learning precedes development. This is in contrast to Piaget's understanding of child development, in which development precedes learning. Vygotsky's theory could be extended beyond children to any person who learns from a more capable authority, which he referred to as a More Knowledgeable Other (MKO). However, he explains that for such development to occur, the interaction needs to be within the Zone of Proximal Development (ZPD). Crawford (1996) explained the ZPD as the distance between a student's ability to perform a task under adult guidance and/or with peer collaboration, and the student's ability to solve the problem independently. According to Vygotsky (1978), learning occurs in this zone.

Cognitive constructivism, spearheaded by the Piagetian cognitive theory is a comprehensive theory about the nature and development of human intelligence, the nature of knowledge and how humans gradually acquire, construct and use it. According to Piaget, cognition development is a progressive reorganisation of mental processes as a result of biological maturation and environmental experiences. This theory focuses on development rather than learning. It proposes different stages of development, marked by qualitative differences, rather than a gradual increase in the number of complexities of behaviours, concepts and ideas, recognising the important role of the schema (building block of knowledge), assimilation, and accommodation of the process that enables the transmission from one stage to another in the knowledge consolidation route.

In the Social Cognitive Theory, human functioning is viewed as a dynamic interaction between the person, behaviour and the environment. This means that how people interpret the results of their own behaviour informs and alters their environments and the personal factors they possess, which, in turn, informs and alters their subsequent behaviour (Fanni, Rega & Cantoni, 2013). This is the basis of Bandura's (cited in Fu, 2013) conception of reciprocal determinism - the notion that cognition affects biological events which are behavioural and environmental influences which create interactions that result in a triadic reciprocity (Usher, et al., 2011).

In the teaching and learning environment, the constructivist framework proposed that learning results from the construction of knowledge when the student interacts with

his/her physical and social environment; since knowledge and experience play an important role in thinking, individual differences in development and in readiness for various types of learning should be expected. Hence, students should have opportunities to plan and organise their own learning and problem-solving and work collaboratively with others. It also acknowledged that teaching involves the creation, management, monitoring and evaluation of appropriate environments to facilitate learning; with sustained thinking and opportunities for in-depth explorations. Within the constructivist domain, evaluation should be designed to encourage reflection and learning.

A blend of these two theories forms the constructivist model on which the contemporary theories are developed. In the constructivist view knowledge is constructed and not transmitted. Further, knowledge construction is embedded in meaningful activity that is anchored and indexed by context. However, one should understand that meaning is determined by the social beliefs that exist in a learning environment at a particular point in time.

### **2.6.3 Learning theories and ICT integration**

ICT alone does not produce learning, but can be used to enhance learning. Literature generally describes three major categories of instructional use for computer-based technologies, and these are; learning from computers, learning about computers and learning with computers.

In the expanded capacity, learning from, and with, ICTs could provide a very useful conceptual framework when integrating ICT into teaching and learning. These two focal points lend themselves to two dimensions of learning theories, namely, behaviourist and constructivist, as discussed earlier. Learning from ICT such as computers inclines towards the behaviourist frame, whilst learning with ICT is underpinned by the constructivist paradigm (Tay, et al., 2012).

#### **2.6.3.1 Learning from ICTs**

In this process, technology is used to convey information or skills to students without their active involvement. A reflection of the traditional classroom practice is where the users are relatively passive, the content and interaction between the user and the software are predetermined, and there is a limited repertoire of acceptable responses, and the acquisition of facts occurs through repeated practice and rote

memory, or learning from the technology (Ross et al., 2010; Jonassen, 2010). Practical use of ICT in this mode includes computer assisted instruction, integrated learning systems, computer-based tutoring systems and computer assisted instruction (CAI). Research on CAI found numerous methodological problems, though many studies have demonstrated positive effects of using CAI. However, Becker (1992) established that the differences between CAI users and non-users are too small to have educational significance. In this case the computer is considered as a tutor, and thus instructs.

This approach is associated with the traditional view of teaching and learning underpinned by the behaviourist theory. The traditional view is that people learn from technology, which is challenged by Jonassen, et al. (2010). They claim that people learn from thinking, and thinking mediates learning, therefore learning is a product of thinking. The understanding here is that technology is instructed to perform the act as instructed by a more knowledgeable other who in essence does the thinking.

### **2.6.3.2 Learning about ICTs**

Another use of technology in schools, that exemplifies traditional learning environments, includes learning about the technology itself (Jonassen & Reeves, 1996). In this approach, the computer is studied as a course where students learn specific skills related to using the computer, such as keyboard skills, ethical uses of computers, or a particular programming language, but these skills are not tied to other content. Here the computer is not used as a teaching and learning tool (Ross et al., 2010).

### **2.6.3.3 Learning with ICTs**

Learning with technology drives much of the current thinking about the use of technology to support learning (Jonassen & Reeves, 1996). According to this perspective, technology is an integral part of the classroom learning environment, and is used as a tool by both teachers and students to facilitate knowledge construction.

Ordinary application software such as word-processing, spreadsheets, graphics, presentations, and database software, problem-solving software, simulations, electronic mail, and the Internet, are technology tools that fit into this category.

Because of the interactive nature of technology and the power of its information-processing capabilities, Jonassen (1996) proposes that when students learn with technology, it becomes a "mindtool". He defines mindtools as "computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner, in order to engage and facilitate critical thinking and higher-order learning" (Jonassen & Reeves, 1996: 9).

Learning with ICT facilitates learning of higher-order thinking (Jonassen et al., 2010) which is more than the simple recall of facts or information retrieval. It is a function between cognitive strategies, meta-cognition and non-strategic (domain specific) knowledge during novel problem solving (Young, 1997). The pedagogical orientation in this domain is dialogic. This indicates that the role of the teacher and technology is indirect, since they do not necessarily lead to thinking, and as such they are only tools and intellectual partners to support learning by affording assistance to students for thinking. This is how knowledge is constructed.

The discussion above examines how technology can be used to support the creation of classroom environments, based on the instructional implications of the learning theories and the integration of technology in teaching and learning. This discussion is based on the premise that it is learning with, not from or about, technology that makes computer-based technologies important tools in a contemporary learning environment, for the development of 21<sup>st</sup> century skills.

## **2.7 SUMMARY**

Much research has been conducted on the use of ICT in education, guided by the potential and benefits of technology, and how it can transform education to contribute to globalization and the current digital economy. Teachers have been recognised as the agents of change and, if well-equipped technologically, can affect the expected reforms in education. Whatever their ICT competency, technology skill development and acquisition of the necessary technical knowledge depends largely on the type of training they obtained from their initial teacher education. Though little impact data has emerged from these projects, it is understood that teacher trainers hold the key to these developments. Lecturers' effective and efficient integration of

ICTs with a transformed pedagogical approach in curriculum delivery will have an impact on these required skills in student teachers, and in turn improve subject matter delivery in schools.

Literature contends that when used appropriately, ICTs enable new ways of teaching and learning, rather than simply allowing teachers and students to do away with, or blend, emerging pedagogy with traditional pedagogy to improve on what they do in the classroom. These new ways of teaching and learning underpinned by constructivist theories of learning drive the process away from teacher-centred pedagogy to a learner-centred approach.

This chapter explored research conducted on the pedagogical integration of ICTs in education, its benefits, and barriers that limit its implementation, and it was identified that the problems lie mostly with school teachers and infrastructure. However, the gap identified is the implementation of ICTs in ITE which could develop and skill student teachers to integrate ICTs in teaching and learning. The chapter concluded by reviewing the sceptics' views on the integration of ICTs on curriculum delivery.

It is clear from research that the use of ICTs in education is a contemporary issue and therefore must be tackled within a contemporary context. ITE institutions must take up the challenge to train teachers to be sufficiently competent to use ICTs effectively in their classrooms.

## CHAPTER 3

### RESEARCH DESIGN AND METHODOLOGY

#### 3 INTRODUCTION

The researcher concluded the previous chapter by noting that the use of ICTs in education is a contemporary issue and therefore must be tackled within a contemporary context. This poses a challenge to ITE institutions to produce mathematics, science, and technology teachers competent enough to infuse ICTs into their professional practice.

The research questions that serve as a guide to the aims of this study are the following:

##### **Main question**

How is ICT integrated in the teaching and learning of mathematics, science and technology education (MSTE) in a Bachelor of Education programme?

##### **Sub-Research questions**

How are MSTE students' and lecturers' belief systems (ontology) and perceptions (epistemology) reflected in the integration of ICTs in teaching and learning?

In what ways are ICTs used to support students' innovation and creativity in MSTE?

How are ICTs used to support students' conceptual understanding of mathematics, science and technology education?

In this chapter, the research design, as well as the methodology used to describe and capture data, is discussed. Further, the researcher discusses the philosophical assumptions and basic beliefs that underpin the research process. The researcher then provides guidelines to explain how the research was conducted, and the

methods and techniques adopted when conducting the research. The discussion of these tools is followed by an explicit plan of action. This plan includes the techniques employed in the execution of the research, including sampling, data collection and analysis. The last part of the chapter relays ethical considerations of this qualitative research study.

Furthermore, the researcher discusses the setting, population, and sample, as well as the data-collection instruments, the sort of data that each instrument allowed him to gather, and how that data was managed and analysed.

### **3.1 RESEARCH ASSUMPTIONS**

Personal philosophical assumptions influence a researcher's stance towards the nature of reality; how the researcher knows what she or he knows, and the role of values in the research, the language of research and the methods used in the process (Creswell, 2009). The researcher developed perceptions of the nature of mathematics, science and technology through many years in the classroom, interacting with many teachers involved in teaching these subjects, and observing the difficulties students faced in studying these subjects. Secondly, the researcher's knowledge of these subjects, and how the researcher struggled to learn them informed and directed what the researcher chose to investigate, the research design and data collection instruments. The participants were the researcher's students and colleagues. This allowed for effective collaboration and interaction with the participants, thus minimising the "distance" or "objective separateness" (Guba & Lincoln, 2005). This also, contributed positively to the distribution of the questionnaire, its collection, and follow-up interviews as sources of data.

To the realist, the social world is made up of relatively immutable structures that exist independently of our individual descriptions (Guba & Lincoln, 1994). Reality is subjective and multiple, as seen by the participants in the study. With this belief, the researcher used multiple quotes in the participants' own words, how they viewed their respective experiences, provided evidence of their different perspectives and identified themes that emerged. The nature of knowing and constructing knowledge, epistemology, ontology and pedagogy were the central components of the study.

True objectivity as an external observer is possible by looking for regularities and causal relationships, to understand perceptions. To achieve this, the researcher established a good level of rapport and empathy, which is critical to gaining depth of information, since the participants have a strong personal input of the issue studied.

In a qualitative research process, it is important to acknowledge that research is value-laden, and that those values mediate and shape what is understood. This formed an integral component that shaped the narrative and the interpretation, in conjunction with the presentations by the participants. Also, the qualitative study procedure, or approach, is characterised as inductive, emerging, and shaped by the researcher's experience in collecting and analysing data (Creswell, 2009). Ideographic approaches were verified and adopted for the subject investigated. These centred on reasons why individuals create and interpret their world in a particular way (Putman, 1983) which uses inductive logic, studies the topic within its context, works with particulars before generalisation, describes in detail the context of the study and uses emerging design (Creswell, 2009).

Next, the researcher outlines a description of the research paradigm in which the study is framed.

### **3.2 THE RESEARCH PARADIGM**

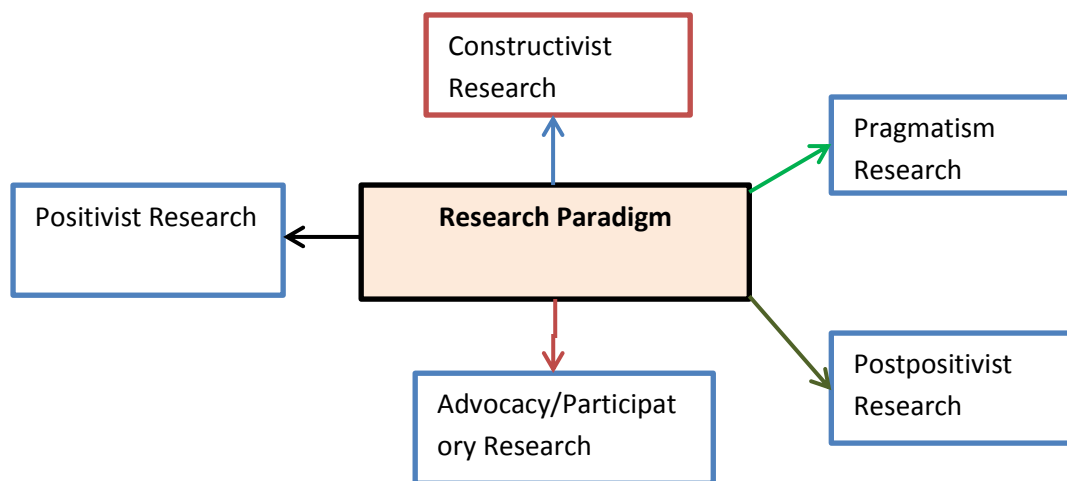
To ensure a strong research design, it is important to use a research paradigm that is congruent with my beliefs about the nature of reality, while consciously subjecting such beliefs to an ontological interrogation

A paradigm, or "worldview", is a basic set of beliefs that guide action (Guba & Lincoln, 2005), and in qualitative research, vary depending on the type of belief the researcher brings to the research. It is also simply a coherent belief structure (or theory) that guides the way we do things (as a lens through which to view the world), or more formally, establish a set of practices. It is a bundle of assumptions about the nature of reality, the status of human knowledge and the kinds of methods that can be used to unfold answers to research questions.

Furthermore, it provided a conceptual framework for seeing and making sense of the subject. The research paradigm was very significant in the sense that it shaped how the researcher perceived the study and was reinforced by the participants' environment. It also helped to identify the researcher's role in the study and steered the course of the research.

The research focus and questions made the choice of the paradigm that shaped the research project constructivist; however, there is a brief discussion of four other worldviews that shape qualitative research which will substantiate the rationale for the choice of the particular paradigm for this study.

In figure 3.1 below, the researcher presents a conceptual frame of various research paradigms.



**Figure 3.1: Research paradigms**

### 3.2.1 Positivism

The positivist paradigm contends that all factual knowledge is based on the 'positive' information gained from observable experience, and that any ideas beyond this realm of demonstrable fact are metaphysics. Positivism seeks empirical regularities, which are a correlation between two variables (dependent and independent) which do not need to be causal in nature, but it does allow laws to be defined and predictions made.

Positivists believe that reality is stable and can be observed and described from an objective viewpoint (Yin, 2003) and that phenomenon should be isolated and observations should be repeatable. This often involves the manipulation of reality (knowledge construction) with variations in only a single independent variable (technology) in order to identify regularities in, and to form relationships between, some of the constituent elements of the social world (teaching and learning). Yin argued that predictions can be made on the basis of the previously observed and explained realities and their interrelationships and also, only analytical statements are permissible as true through reason alone.

Table 3.1 below is a comprehensive display of the tenets of positivism looking through the lens of Yin (2003).

<b>Tenet</b>	<b>Meaning</b>
Naturalism	The principle of the natural sciences should be used for social sciences
Phenomenalism	Only observable phenomena provide valid information
Nominalism	Words of scientific value have fixed and single meanings. The existence of a word does not imply the existence of what it describes.
Atomism	Things can be studied by reducing them to their smallest parts (and the whole is the sum of the parts)
Scientific laws	The goal of science is to create generalised laws (which are useful for prediction).
Facts and values	Facts are to be sought. Values have no meaning for science.

**Table 3.1: The tenets of positivism**

From these tenets, positivism is associated with the physical and natural sciences; secondly knowledge claims that are not grounded in positivist thought are simply not scientific and are therefore invalid.

### **3.2.2 Post positivism**

Positivism contains two main themes, namely controlling the research conditions such as human behaviour and investigating those through scientific methods (Douglas cited in Cohen, Manion & Morrison, 2000). The aim of inquiry is explanation, ultimately enabling the prediction and control of phenomena, whether physical or human (Guba & Lincoln, 2008), and because of these controls, they tend to generalise findings with one truth. As it is very structured and clear, it is easy to be objective. Post positivists work from the assumption that any piece of research is influenced by a number of well-developed theories apart from, and as well as, the one which is being tested, as such hypotheses have to be tested by empirical approaches.

Postpositivism contends that reality is assumed to exist but is only imperfectly apprehendable because of basically flawed human intellectual mechanisms and the fundamental intractable nature of phenomena, with objectivity its regulatory idea (do findings “fit” with pre-existing knowledge?). They place emphasis on “critical multiplism” (Guba & Lincoln, 2008) as a way of falsifying (rather than verifying) a hypothesis, claiming that knowledge is non-falsified hypotheses that can be regarded as probable facts or laws.

It is interesting to note that positivists tend to control publication outlets, funding sources, promotion and tenure mechanisms and other sources of power and influence. They were, at least until about 1980, the ‘in’ group, and continue to represent the strongest voice in professional decision making (Guba & Lincoln, 1994:117). However, this study is qualitative with no controlling factors, hence falls way out of this paradigm.

### **3.2.3 Advocacy/Participatory**

The key tenet of this paradigm is that research should be action directed and geared towards reform that may benefit, improve or change the lives of the participants, the institution and the environment in which they live and work, or even the researchers’ lives (Creswell, 2009). As the issues are studied and exposed, the researcher provides a voice for the participants, raising their consciousness and improving their lives.

According to Kemmis and Wilkinson (1998) the main features of this paradigm are:

It is recursive and focuses on bringing about change, so is action agenda driven.

It focuses on creating awareness and arousing consciousness of participants' situations and helps them to set themselves free from such settings.

It is emancipatory, in that it helps unshackle participants from the constraints of irrational and unjust structures that limit self-empowerment by creating the opportunity for debate and discussion for change to occur.

It is practical and collaborative, since it is an inquiry completed "with" others rather than "on" or "to" others, and thus engages participants as active collaborators in the study.

In this study, this means advocacy plays a role though not a central one. The study set out to bring awareness, and possibly a change in practice.

### **3.2.4 Pragmatism**

Pragmatist researchers' main focus is on the outcomes of the research, which include the actions, situations, and consequences of the inquiry rather than antecedent conditions and methods. The central point of interest is the problem being studied, and the questions asked about this problem (Creswell, 2009). Cherryholmes (1992) contends that pragmatists are not committed to any system of philosophy and reality, neither to any prescribed approach to collect and analyse data, nor to methods, techniques and procedures of research. Instead, they choose one that best meets their needs and purpose.

To a pragmatist, the mandate of science is not to find truth or reality, the existence of which is perpetually in dispute, but to facilitate human problem-solving. In practice, the researchers using this worldview subscribe to multiple methods of data collection to best answer the research question (Creswell, 2009) and will employ both quantitative and qualitative sources of data collection, with the focus on the practical implications of the research addressing the 'what' and 'how'. Patton (2002) and

Teddle and Tashakkori (2009) are a few of many writers who embrace this worldview. For this research only a qualitative approach is being used, so pragmatism may not be so applicable.

### **3.2.5 Constructivism**

Constructivists argue that human beings construct their own social realities in relation to one another. Reality is subjective and experiential and knowledge is not absolute, and the researcher is no longer outside the system, but part of it. The goal of constructivist research is for understanding and structuring, suggesting that “reality is socially constructed” (Mertens, 2005:9), as opposed to prediction. Constructivists do not generally begin with a theory (as with post positivists), rather they “generate or inductively develop a theory or pattern of meanings” (Creswell, 2003:9) throughout the research process.

As a constructivist researcher, it was important to address the “process” of interaction among the participants. Recognising that my background could shape my interpretation, I positioned myself in the research to acknowledge how the participants’ interpretations flow from their own personal, cultural and historical experiences (Creswell, 2009). It is, however, interesting to note that constructivism and interpretivism are related paradigms to research designs that are characteristic of particular philosophical world views.

Studying individuals with their many characteristics, different behaviours, perceptions, opinions, and attitudes (Cohen, et al., 2000) helps in acquiring knowledge of the issue, and placed this study within the interpretivist framework. The interpretivist paradigm provides opportunities to seek understanding and make sense of the participants’ perspectives which are shaped by social constructions (Taylor, 2008). Through this paradigm, relying on the “participants” views, the researcher obtained a better understanding of meanings, reasons, and insights into the actions of the participants regarding the issue investigated. Furthermore, recognising that all the participants involved, including the researcher, brought their own unique interpretations of the world or construction of the situation to the research, required that the researcher opened up to the attitudes and values of the participants or, more actively, suspended any prior assumptions (Mackenzie & Knipe, 2006) with a focus on the collaborative process of bringing about meaning

and knowledge. Thus, a case study design was suitable for the study. It must be noted that this subjectivity led to a result that was relatively complex to analyse and interpret objectively.

A comprehensive discussion of this paradigm, which forms the conceptual base of the theoretical framework of the study, appears in chapter 2 of this document. In the next section the researcher discusses the research approach adopted for this study.

### **3.3 THE RESEARCH APPROACH**

Approaches to research provide solutions to problems and, almost paradoxically, create new problems to be solved. A research approach is a plan for assembling, organising and integrating information (data) and results in a specific product (research findings) which Merriam (1998:6) compared to an “architectural blueprint”. The choice of a particular approach is determined by the shape of the research problem, the questions it raises, and the kind of end product desired. Against this background, it is important for the researcher to have adequate understanding of the methodological and analytical tools available, their uses and shortcomings.

A research approach could be classified as quantitative, qualitative or mixed methods (a hybrid or blend of quantitative and qualitative). The research approach of this study originated from the research problem discussed in chapter 1, and can be described as qualitative, descriptive, exploratory and interpretive. Before exploring the qualitative approach adopted for this study, there is a brief discussion of the other two approaches.

#### **3.3.1 Quantitative**

Quantitative research refers to the systematic empirical investigation of social phenomena, via statistical, mathematical or computational techniques. The objective of quantitative research is to develop and employ mathematical models, theories and/or hypotheses pertaining to phenomena. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships. In this regard it is convincing to note that the aim of quantitative research is to

determine the relationship between one thing (an independent variable) and another (a dependent or outcome variable).

Babbie, (2010) states that, the quantitative research approach provides objective and unbiased results that have not been influenced by the researcher. Furthermore, quantitative research is based more directly on its original plans, and its results are more readily analysed and interpreted. Below is a summary of the characteristics of this approach (Burns, 2000:6-7)

“There is a single reality that can be defined by careful measurement; It is usually concise;

It describes, examines relationships, and determines causality among variables, where possible;

Statistical analysis is conducted to reduce and organise data, determine significant relationships and identify differences and/or similarities within and between different categories of data;

The sample should be representative of a large population;

Reliability and validity of the instruments are crucial.

Comprehensive data collected by employing different methods and/or instruments should result in a complete description of the variable or the population studied;

It provides an accurate account of characteristics of particular individuals, situations, or groups”.

The strength of this approach lies in the following: (Burns, 2000:6-7) “Precision through reliable measurement, control through sampling and design, ability to produce causality statements, through the use of controlled experiments, statistical techniques allow for sophisticated analyses and replicability”.

However its limitations include (Burns, 2000:6-7):

“.....difficult to rule out or control all variables because of the complexity of human experience, its mechanistic ethos tends to exclude notions of freedom, choice and moral responsibility, Fails to acknowledge

people's unique ability to interpret their experiences, construct their own meanings; leads to the assumptions that facts are true and the same for all people at all times and It often produces banal and trivial findings of little consequence due to restriction on, and the controlling of, variables”.

Despite the well-articulated characteristics, strengths and limitations, the issue being studied does not lend itself to statistical analysis; rather to a descriptive analysis, so the quantitative approach was deemed not appropriate for the study.

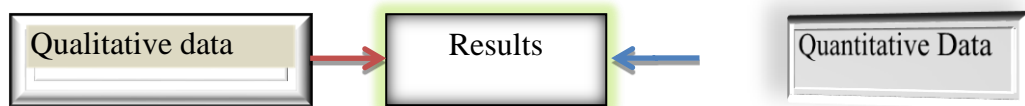
### **3.3.2 Mixed Methods**

Mixed methods research dynamics is the mixture of qualitative and quantitative approaches in many phases in the research process, with a focus on collecting, analysing, and mixing of qualitative and quantitative data in a single study or series of studies (Creswell, 2008). From this definition it is clear that a mixed methods approach combines methodology and methods. As a methodology, it involves collecting, analysing, and mixing qualitative and quantitative settings at many phases in the research process, from the initial assumptions to the drawing of a conclusion. As a method, it focuses on collecting, analysing and mixing qualitative and quantitative data in a single study or series of studies.

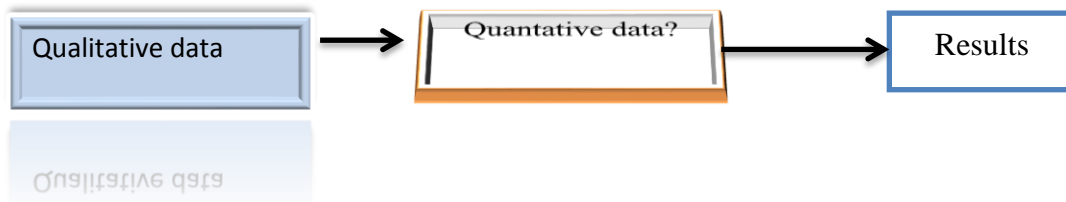
The proponents of this approach contend that ‘mixed methods’ as a research approach provides a better understanding of research problems than either qualitative or quantitative approaches alone. They also claim that it offers strengths that offset the limitations of separately applied qualitative and quantitative research approaches. Furthermore, it encourages the collection of more comprehensive evidence for study problems; helps answer questions that qualitative or quantitative approaches alone cannot answer. Also, it encourages the use of multiple worldviews and is a practical and natural approach to research (Creswell, 2008).

It must be emphasised that it is not enough to simply collect and analyse qualitative and quantitative data; they need to be “mixed” in some way so that they present a comprehensive picture of the issue. Creswell (2008) presents three ways of “mixing” qualitative and quantitative data, as shown below:

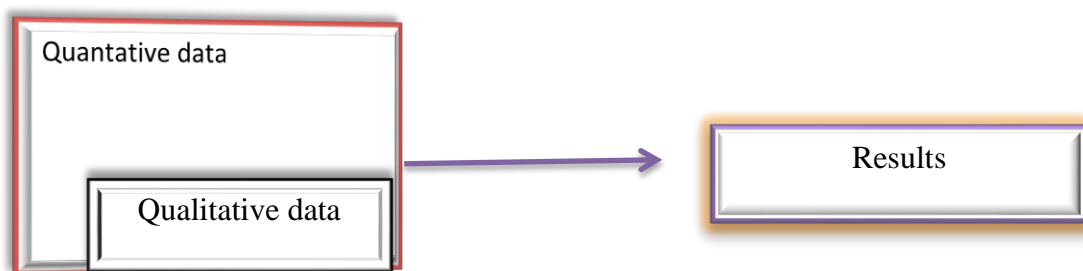
**Merge the data:** Collaboration of data from the two approaches to draw a conclusion



**Connect the data:** In this perspective qualitative data is incorporated into quantitative data to produce a conclusion.



**Embed the data:** In this way, approaches are used alongside each other to obtain an outcome.



**Figure 3.2: Ways of mixing qualitative and quantitative data**

### Limitations

Despite its strengths, useful characteristics, and value, there are a few difficulties associated with the approach, which include, according to Creswell (2008):

Difficulty in conducting mixed methods research.

Enormous time and resources required to collect and analyse both qualitative and quantitative data.

Clear presentation required to enable the reader to sort out the different procedures. Researchers have to be familiar with both qualitative and quantitative approaches. Due to the nature and structure of my research question, I consider this approach to be inappropriate to fully describe the issue under investigation.

### 3.3.3 Qualitative

Creswell (1994:2) defines a qualitative study as an “inquiry process of understanding a social or human problem, based on building a complex, holistic picture, formed with words, reporting detailed views of participants, and conducted in a natural setting”. Furthermore, Creswell (2009:37) shared the view that “qualitative research begins with assumptions, a worldview, the possible use of a theoretical lens, and the study of the research problems inquiring into the meaning individuals or groups ascribe to a social or human problem”. Qualitative research involves a direct concern with experience as it is ‘lived’ or ‘felt’ or ‘undergone’ (Silverman, 2011). Thus, it can be said that qualitative research is more concerned with the meaning of human behaviour and experience and the function of social action. It has the aim of understanding experience as closely as possible to that which its participants feel it or live it.

From the attributes, explanations and definitions, the emerged characteristics of qualitative research can be enumerated as follows:

A qualitative researcher immerses her/himself in the setting to adequately understand the event by identifying it in context.

The contexts of inquiry are not contrived; they are natural. Nothing is predefined or taken for granted.

Qualitative research is an interactive process with participants providing their perspectives on the issue.

Much focus and emphasis is placed on process in attending to the experience as a whole, not as separate variable, but to understand experience as unified (Silverman, 2011).

It is more inductive analysed and grounded theory oriented.

It can therefore be concluded that qualitative research is an inquiry approach useful for exploring and understanding a central phenomenon, whereby the researcher asks broad general questions, collects detailed perspectives from participants in the

form of words, analyses the information with description and themes and, if necessary, generates theory.

The strength of this approach includes (Burns, 2000:13-14):

“Close researcher involvement provides an opportunity to gain an insider’s view of the field and its subtleties and complexities.

Descriptions can play the important role of suggesting possible relationships, causes and effects and as a dynamic process. Therefore, because of its descriptive and narrative dimension, it is of particular benefit to researchers who could use the reports to examine forms of knowledge that might otherwise be unavailable, thereby gaining new insight”.

The limitations are (Burns, 2000:15-16):

“Contexts, situations, events, conditions and interactions cannot be replicated.

Enormous time is required for data collection, analysis and interpretation.

The researcher’s presence has a profound effect on the subjects of study.

Issues of anonymity and confidentiality present problems when selecting findings.

The viewpoints of both researcher and participants have to be identified and elucidated because of issues of bias”.

Notwithstanding its limitation, this approach presents characteristics that best contribute to scaffolding the research study. A detailed discussion is developed within the appropriateness of the research design.

### **3.4 APPROPRIATENESS OF RESEARCH APPROACH**

Although the quantitative / qualitative dichotomy may appear obvious in the discussions, the division may not be as clear-cut as it seems. However, rather than using samples and following a rigid protocol to examine the limited variable, the researcher adopted a qualitative case study approach for an in-depth examination of the event under study.

Silverman (1993) argues that the advantage of qualitative research is that it recognises the inherent subjective nature of social relationship, as qualitative researchers use a naturalistic approach that seeks to understand phenomena in a context-specific setting, such as a real world setting where the researcher does not attempt to manipulate the phenomenon of interest (Patton, 2002). A qualitative, interpretive approach allows acknowledgement of conflict, ongoing struggle, tension and subjectivity, as well as the situated and co-produced nature of accounts (Rubin & Rubin, 2005).

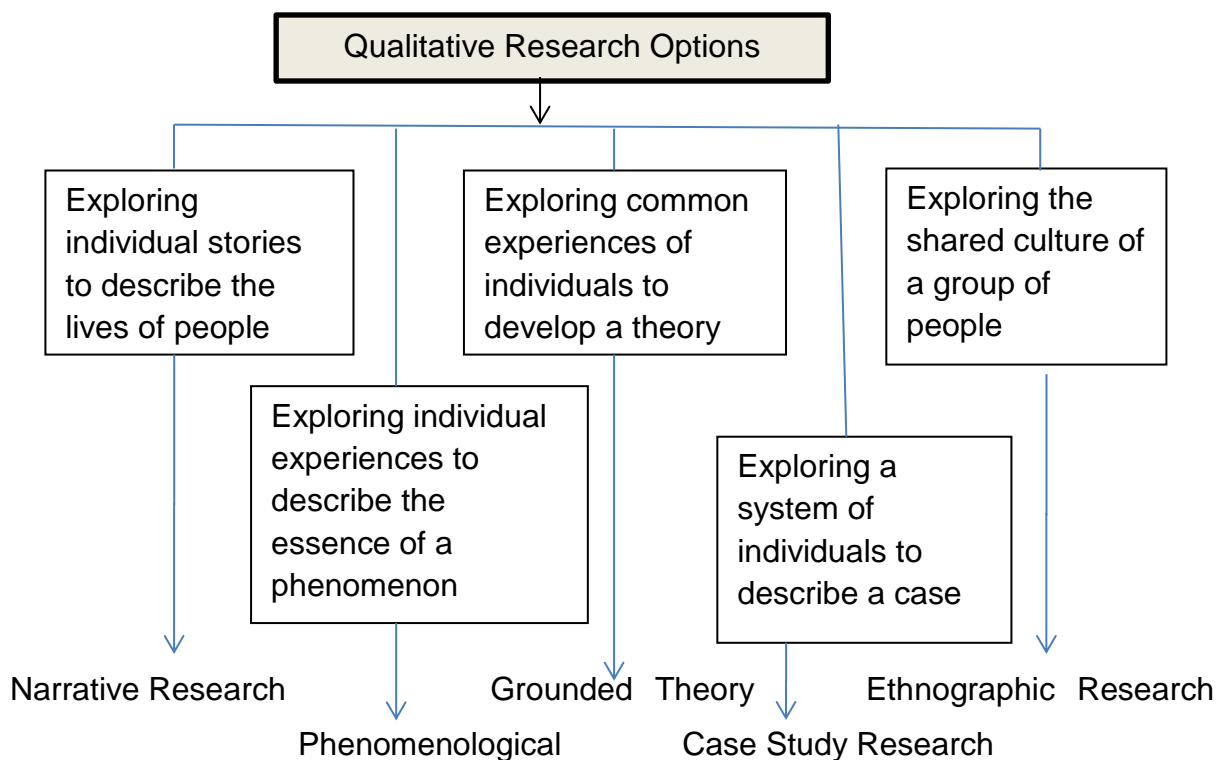
There was a great appreciation of the complex epistemological and ontological differences between qualitative and quantitative research approaches not ignoring the mixed methods approach. However, the characteristics of the qualitative approach and a comprehensive study of the interpretivist stance positioned the study in these arenas. The researcher also employed a rigorous analysis of the nature of the research topic, the main question and the sub-questions, which were answered more effectively by this approach, thus allowed for flexible and descriptive dimensions, to avoid becoming stuck in conventional ways of thinking, or particular sets of assumptions. Furthermore, designing this study as an interpretive case study allowed the researcher to develop conceptual categories inductively to examine initial assumptions (Merriam, 2009), without evaluating, or judging in any way. Ultimately, therefore, the appropriateness and the usefulness of the approach are inextricably tied to the nature of the research question.

As mentioned, the frame of this study was inductive, where general inferences were induced from the study. The primary purpose of the inductive approach is to allow research findings to emerge from the frequent, dominant or significant themes inherent in the raw data, without the restraints imposed by structured approaches. Key themes were often obscured, reframed or left invisible because of the preconceptions in the data collection and data analysis procedures, unlike those imposed by deductive data analysis, as used in experimental and hypothesis testing research.

### 3.5 THE RESEARCH DESIGN

A research design, in the opinion of the researcher, is the conceptual structure within which research could be conducted. It deals with a logical problem through a logical plan for getting from the initial set of questions to be answered to the set of conclusions about these questions. The propositions direct attention to something that should be examined within the scope of study, and determine the direction of the research and research alternatives. A discussion of the research design opted for which appropriate address the research question is put forward in the follow-up section. However, an overview of other options is also outlined.

Creswell (2009) outlined research options that are available in a qualitative research approach with their parameters in figure 3.3 below. However, the researcher will elaborate only on the option relevant to this study.



**Figure 3.3: Qualitative research options**

This study adopted a case study research design, after understanding arguments put forward by Creswell (2009), Yin (2003) and Stake (1995). Furthermore, given the nature of the research problem as discussed in the earlier chapter, a case study option was the appropriate choice for this study. This research design will now be

explored in a little more detail in the next section. However, a few thoughts were given to phenomenological research, since it has the flair of constructivism and a case study research design.

### **3.5.1 Case Study**

Case study, as a research design, has been explored by many researchers and authors (Creswell, 2009; Yin, 2003; Stake, 2003) who arrived at a series of arguments, characteristics and explanations.

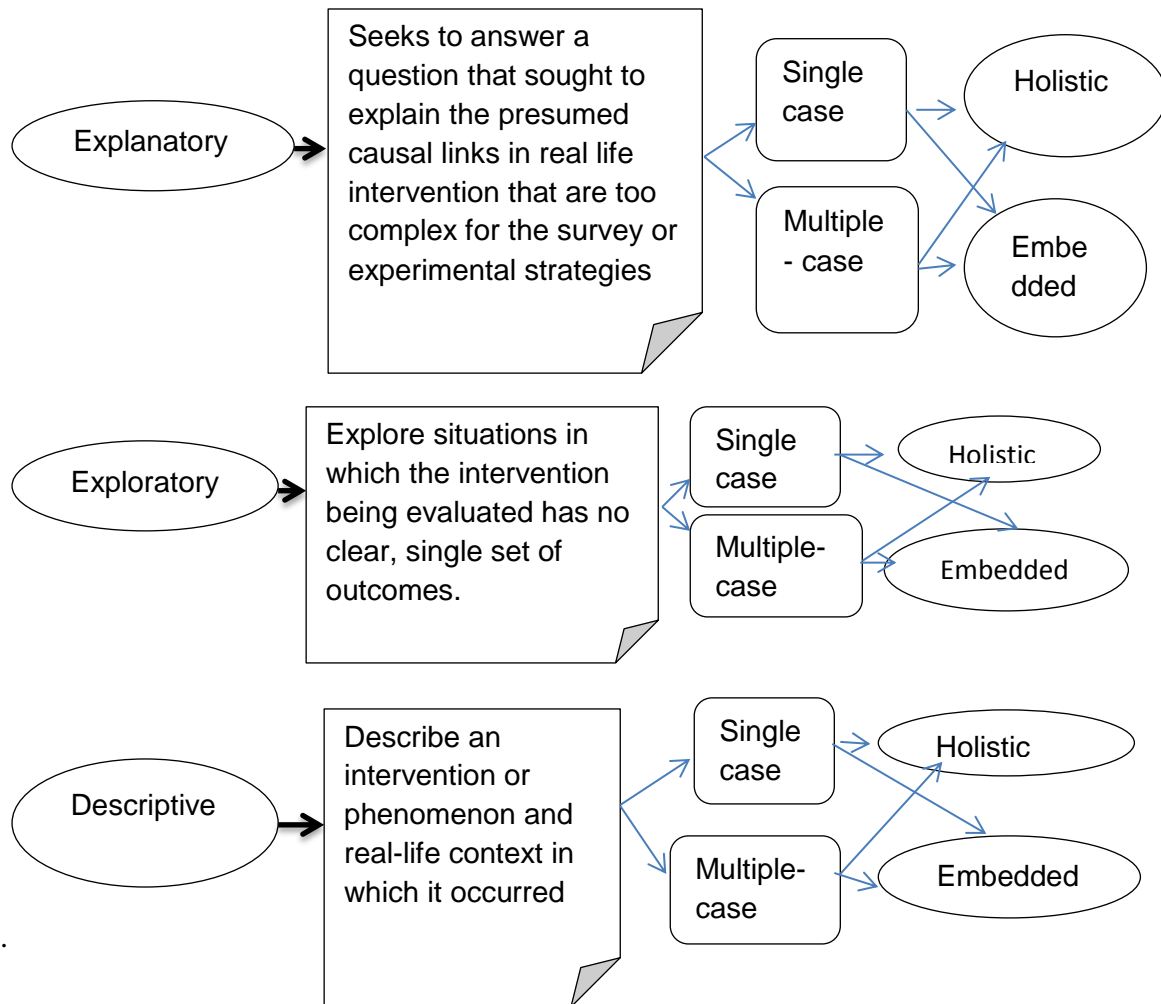
Stake (2003) argues that case study, as a research design, is the study of particularity and complexity of a single case, coming to understand its activity within important circumstances. This means that a case study is an intensive study of a single unit (a spatially bounded phenomenon observable at a single point in time or over a delimited period of time) for the purpose of understanding a large class of (similar) units. Expanding Stake's argument, Yin (2003) explains that a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, when the boundaries between the phenomenon and context are not clearly evident, and in which multiple sources of evidence are used.

According to Flyvbjerg (2011) a case study is an intensive analysis of an individual unit such as a person, group, or event, stressing the developmental factors in relation to context. Hitchcock and Hughes (1995), cited in Cohen, et al. (2000:182), stress that a case study focuses on practice, intervention and interpretation, with the aim of improving the situation. Thomas (2011) posits in his explanation that case studies have the characteristics of analysing persons, events, decisions, projects, policies, institutions, or other systems that are studied holistically by one or more methods.

A case study design, therefore, provides a systematic way of looking at events, collecting data, analysing information and reporting the results. Further, it is an in-depth study of a particular research problem, rather than a sweeping statistical survey. It is often used to narrow down a very broad field of study into one or a few easily researchable issues. As a result, it could be used to obtain a sharper understanding of the pedagogical integration process of ICT in ITE, which is the objective of the project.

### 3.5.2 Types of Case Study

Yin (2003) categorises case studies as explanatory, exploratory or descriptive, whilst Stake (2005) identifies additional case studies as intrinsic, instrumental or collective. In figure 3.4 below is a summary of various dichotomies of case studies, and a brief background of each with operational circumstances..



**Figure 3.4: Types of case study**

According to Stake (2005), an “intrinsic case study” occurs when the researcher has an interest in the case; “instrumental” is when the case is used to understand more than what is obvious to the observer, and “collective” is when a group of cases is studied. The collective case studies can be linked with multiple-case studies.

The research design explored contributed to the decision of positioning the study as a holistic multiple-case exploratory case study, given the nature of the research problem outlined in chapter 1. It is holistic because it comprises a single unit of

analysis, and multiple-case, since it follows a replication logic which adds to the body of knowledge on the pedagogical integration of ICTs by lecturers of ITE. It concentrates especially on mathematics, science and technology education and how to improve the quality of teaching and learning in these learning areas. Each individual case study consists of a “whole” study, in which the facts were gathered from various sources.

The execution of this study draws on the work of Creswell (2009), Yin (2003) and Stake (1995) in terms of the stages of the research project (which had some overlaps at some stages):

*Selecting the cases:* The cases were selected after carefully observing how lecturers and students use ICTs in teaching and learning.

*Preliminary investigations:* These were conducted through verbal interaction with many colleagues and students before selecting the cases and formulating the research project.

*Data gathering stage:* This stage involved the gathering of qualitative data through a questionnaire (open-ended), interviews (semi-structured), documents and field notes.

*Analysis stage:* This commenced just as the questionnaire was collected, which provided direction for the development of the interview, both of which continued until the write-up stage.

*Report stage:* The elements (chapters) were produced as the analysis began and continued until the final submission.

The researcher will now discuss the cases concerned in the study:

### **3.6 THE CASES**

In this study, the researcher sought to discover how lecturers' ICT pedagogy in mathematics, science and technology education in ITE articulated the use of technology tools in teaching and learning for conceptual understanding, thereby

setting the agenda for quality education, students skills and conceptual development. The researcher also examined the use of ICT's translation into conceptual changes in teaching and learning of mathematics, science and technology.

Secondly, he investigated how students engage ICTs to construct knowledge, and develop skills, and for conceptual understanding, with the help of lecturers and assistance from the Information Technology (IT) section of the institution. Each of the two cases selected provide insight into significant use of ICTs, by highlighting different perspectives on the same issues (Creswell, 2009). The outcome is a rich and detailed description of perspectives, with analyses from each case, which contributed to the knowledge base of the pedagogical integration of ICTs in mathematics, science and technology education. The two cases were suitable for the study, due to their commonality (Cohen, Manion & Morrison, 2003; Stake, 1995).

### **3.7 SELECTING THE CASES**

The cases were selected because of special interest. In selecting the cases, the researcher considered the availability of resources, and how they are used to benefit all the parties involved in ITE.

The first case (lecturers) was selected because of the nature of curriculum delivery and how they implemented the available resources and services (blackboard) at their disposal, with a special interest in the efficient and effective manner in which these resources were used in curriculum delivery (cf. chapter 4).

The second case was the students. An initial complaint about their inability to use ICT's effectively for creative learning and verifying information accurately, revealed their weakness in using ICT in their learning process (cf. chapter 4).

The two cases were supported by the Information Technology (IT) section of the institution which is tasked to provide an IT service. The section also manages the Blackboard system and other technology related services. The researcher had an in-depth chat with one of the personnel from this section regarding the study, and explained how valuable his input is to this study.

### **3.8 PRE-TESTING**

Before administering the questionnaire and embarking on the interviews, these research tools were tested on non-participants, comprising one lecturer who belongs to the Department of Mathematics, Science and Technology Education, but who volunteered to be in the pre-testing group, and four 3rd-level students who were studying mathematics, science and technology but were not involved in the study. Therefore, the respondents selected for the pre-testing constituted 10% of the sampled study population and were broadly representative of the type of respondents interviewed in the main study.

Bourque and Fielder (2003) suggest that a pilot test enables researchers to determine how well their questions and instructions are understood. Furthermore, it helped clear up any misunderstandings and ambiguities in the questionnaire, determined whether the questions as they were worded would achieve the desired results, whether the questions were placed in the best order, and whether additional questions were needed, or whether some of the questions should be removed. The lessons learned from the pilot study were useful and influenced decisions made in the main study. It also contributed to refining the research process, settling on a style of interviewing, and enabled me to gain confidence in the process and confirm the efficiency of the instruments.

### **3.9 THE SETTING**

The study took place in the Limpopo Province of South Africa. The province hosts two previously disadvantaged tertiary institutions which are evidently under-resourced institutions and lack ICT resources. A restructuring programme, currently embarked upon, has seen these universities doing their best to equip all sections and departments with ICT resources for facilitation of learning and programme management. Technologies in these institutions have improved and the community at large is expected to adapt to the changes and drive towards progress. Therefore the onus lies on lecturers of ITE to integrate technology in the teaching and learning process, so that it supports instruction and enables students to use ICT tools to meet their information and learning needs. Furthermore, to use ICT to develop conceptual

understanding, improve collaboration as well as developing the necessary skills towards life-long learning, so as to face the world with confidence.

### **3.9.1 The Participants**

There are two ways of recruiting respondents for qualitative study. One is to go out armed with screening questionnaires and to find quotas of respondents, and the other is to use an existing group of potential respondents, called a panel, who all agree in principle to participate in the research (Healey, 2012). The researcher used the latter option, though there was no existing panel, hence a ready sampling frame was used. The first and second case respondents were from the same school and department, but the supporting respondent was from a section in the institution which is responsible for IT services in the institution.

### **3.9.2 Population**

Seaberg (1988:240) defines population as “the total set from which the individuals or units of the study are chosen”. According to Polit and Hungler (1999:37), population refers to “an aggregate or totality of all the objects, subjects or members that conform to a set of specifications”. From these perspectives, the population in this study refers to the entire HEI community (students, academics and non-academic staff) with special interest in DMSTE where the study was conducted. The eligibility for this study required the participants to be students reading any two of the subjects of mathematics, science and technology as majors, and should have been in the institution for at least four years of study. Lecturers needed to be teaching any of the subjects of mathematics, science and technology education in the department for at least four consecutive years, and lastly, Information and Technology section staff involved had to be education technologists who provided IT support for academic staff and students.

### **3.9.3 Sampling**

According to Vockell & Asher (1995:170), sampling refers to strategies that enable us to pick a subgroup as a basis for making inferences about the larger group. Reasons for sampling are numerous, some of which are feasibility and working with a subgroup (sample) to generate data that will be easy to work with, but must be a true representation of the larger group. A “sample” is a subset of the population,

selected by random or non-random “probability” methods. However, the latter is more dominant in qualitative studies.

There is a host of sampling strategies in qualitative studies, including intensity sampling (participants are selected, who enable study at different levels in the subject under study), homogeneous sampling (selection of people with similar outlooks and/or backgrounds, whose views as a group are examined), snowball sampling (“bring your friend” approach, in which participants identify other people who would also meet the requirements of a particular study), random purposive sampling (a selected few of a larger group randomly selected to participate) and purposive sampling (hand-picked subjects on the basis of specific characteristics).

Onwuegbuzie & Leech (2007) suggest that in qualitative research the sample size should not be so large that it becomes difficult to extract thick, rich data. On the other hand, Flick, Von Kardorff, and Steinke, (2004) and Morse (1995) noted that the sample should not be too small, so that it is difficult to achieve data saturation. In all these cases no specific ideal figure has been suggested, thus the onus lies on the researcher to determine the number of participants for a study. Some scholars speculate that ten to twelve participants may prove sufficient in qualitative inquiries involving the understanding of experiences and perceptions of participants.

As a qualitative researcher who wants to see the world through the eyes of the participants, to describe the context in detail, investigate how the situation came to be and its effect, approach the research with flexibility and the capability to change, and show how social change could occur, the researcher resorted to a non-random probability purposive sampling technique in selecting the participants for the study. This provided for relatively equal numbers of different people to enable exploration and description of the conditions and meanings occurring within each case in the study. However, fifteen participants were targeted for the study (cf page 91).

The province where the study was conducted boasts two universities. One with a Department of Mathematics, Science and Technology Education was engaged for the research. Four lecturers (1 for chemistry, 1 for physics, 1 for mathematics and 1 for technology), six students (2 majored in mathematics and science [chemistry and

physics], 2 majored in mathematics and technology and 2 majored in science and technology) all fourth year students, and one IT staff (education technologist) of the HEI, were recruited for the study.

### **3.10 DATA COLLECTION TECHNIQUES**

In the first chapter, the researcher mentioned that the data for this study was drawn from different sources, using two tools. However, three modes namely questionnaires, interviews and field notes were used to capture the participants' views, perceptions and experiences. The section below is a discussion of the techniques (methods) employed to obtain data from the participants.

#### **3.10.1 Field notes**

Field notes are one of the primary forms of data collection in qualitative field research. Notes taken in the field are meant to capture details about events, people, places, meanings attributed to interactions, and researcher reflections. Face-to-face interviews allowed the observation of not only verbal, but also nonverbal data (Hiller & DiLuzio, 2004). Contemporaneous scratch notes of observations of participants' non-verbal physical expressions that filtered through during the in-depth interview process, were taken and then expanded as another data gathering source.

The participant and the researcher had access to facial expressions, gestures and other para verbal communications during the session, which the researcher tried to describe and commented on, and included thoughts about the setting, the respondents and activities which enriched the meaning of the spoken words (Carr & Worth, cited in Knox & Burkard, 2009). Therefore, in this context, the field notes were understood as an objective record of observations made.

Schatzman and Strauss (1973) advocate the organization of notes into three categories:

- Observational notes; statements bearing events experienced principally through watching and listening.
- Theoretical notes; self-conscious, controlled attempts to derive meaning from any one or several observation notes.

- Methodological notes; statements that reflect an operational act completed or planned: an instruction to oneself, a reminder, a critique of one's own tactics.

In this study the 'observational' notes were applied since the characteristics fit well within the context of the research. Further, the researcher adopted an interpretative approach, and with this orientation allows the researcher to treat the participants' social actions and activities as text (Miles & Huberman, 1994).

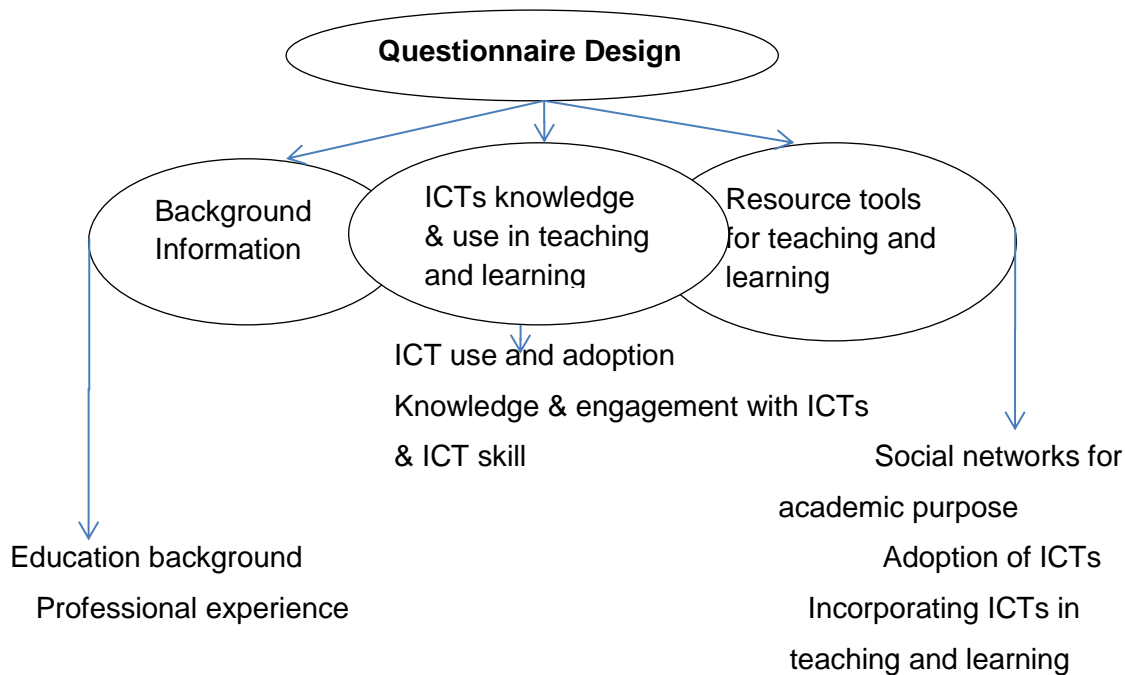
### 3.10.2 Questionnaires (Appendixes A – F: pg. 216-253)

To investigate the issues under consideration in this study, the researcher designed questionnaires of unstructured open-ended questions, which were answered by the three different categories of participants (students, lecturers and IT staff).

#### 3.10.2.1 Designing the Questionnaire

The questionnaire was designed to investigate the individual's background, the use and application of the systems provided by the institution to advance all of the respondents' involvement in ICT engagement, and their use of ICTs in academic development (included in Appendix A: pg. 216; C: pg. 234 & E: pg. 250).

The figure below shows the areas covered by the questionnaire.



**Figure 3.5: Questionnaire protocol**

An open-ended questionnaire was designed to encourage full and meaningful answers using the subject's (participant's) own knowledge, understanding and/or feelings. Open-ended questions also tended to be more objective and invited free ranging responses which were extremely useful in eliciting deep understanding of the respondents' perspectives.

### **3.10.2.2 Administering the Questionnaire**

The questionnaires were self-administered due to the proximity of the participants. Neuman (1997:38) lists two major advantages of self-administered questionnaires:

“The research can be conducted over a wide area, and distance does not present restriction, and this type of questionnaire offers anonymity and minimises researcher bias”.

Notwithstanding these advantages, the method was also subjected to a number of disadvantages as outlined by Bourque & Fielder (1995:14), DeVaus (1996:108) and Oppenheim (1992:102):

“No control over who responds to the questionnaire, and whether or not that person “consults” with colleagues or peers while completing it. Misunderstandings cannot be cleared immediately”.

However, adequate steps were taken to overcome or minimise these disadvantages to ensure authentic responses to the questions. A special appeal was made to the participants to respond to the questionnaire independently so that a clear understanding of the issue under study could be obtained. Also, piloting the questionnaire cleared up any handicaps in terms of the wording and layout.

A total of fifteen questionnaires (eight to students, five to lecturers and two to IT staff) were self-administered, of which eleven were received back (six from students, four from lecturers and one from the IT staff) indicating a good return. It is worth mentioning that the researcher had one-to-one discussions with each participant, explaining in detail the purpose of the questionnaire, their responsibility, as well as mine, and motivating them to respond honestly and to the best of their ability. There was also a written consent letter issued to them, assuring them of confidentiality (Appendix M: pg. 297; N: pg. 298 & P: pg. 299).

### **3.10.2.3 Discussion of the Questionnaire**

The questionnaire comprised twenty questions grouped into three sections (Appendices A: pg. 216; C: pg. 234, & E: pg. 250).

Section A comprised one question, made up of eight sub questions soliciting the demographic characteristics of the participants (gender, qualification, school, experience etc.). This provided the opportunity to link the information given to their experiences and understanding of issues.

Section B was made up of four questions targeting the participants' ICT background knowledge and experience with respect to ICT productivity tools and resources that are available in the institution.

Section C consisted of fifteen questions seeking information on ICT knowledge and usage. These covered the application, infusion and transformation stages of ICT development (cf. chapter 2).

The questionnaire data was captured for each case, question by question, in order to identify similarities and categories that emerged (Appendices B: pg. 220; D: pg. 238 & F: pg. 253)

### **3.10.3 Interviews**

Interviews are one of the most common forms of qualitative research methods (Flick, Von Kardorff & Steinke, 2004; Silverman, 2011; Mason, 2002; Merriam, 2009), which involve the construction or reconstruction of knowledge. Anderson (1990:222) defines an interview as “a specialised form of communication between people for a specific purpose, associated with some agreed subject matter”. Kvale (1996:77) puts it this way: ‘The qualitative research interview seeks to describe the meanings of central themes in the life world of the subjects’. The main task of interviewing is to understand the meaning of what the interviewees say. Cohen and Manion (2007) suggest that research interviews serve three main purposes. They are a principal tool for gathering data; can be used to test a hypothesis or generate one, and as a supporting tool for the purpose of triangulation; or can be used to probe deeper into elements uncovered by other methods.

Despite its disadvantages, such as being prone to bias, time-intensive and time consuming, the advantages, such as providing more detailed information than other data collection methods, providing a more relaxed atmosphere in which to collect information, providing rich and thick data, providing insight into respondents' perspective, gathering new knowledge and thoughts, and developing a personal relationship in interacting with participants, far outweigh the limitations and pitfalls. To counteract these pitfalls and limitations, the researcher undertook corrective action during the process.

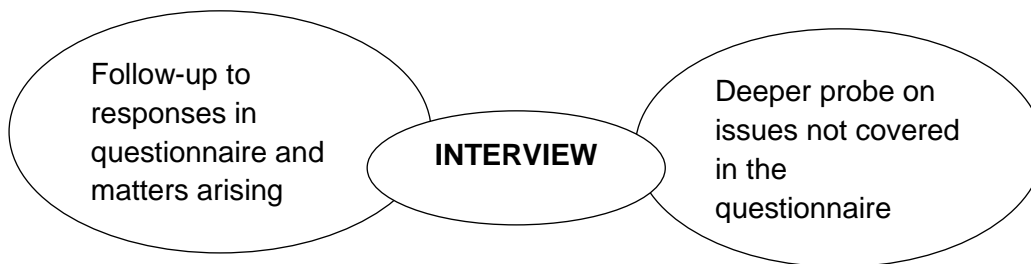
The style of interview conducted in this study is greatly influenced by the overarching qualitative paradigm. Kvale & Brinkman (2009) describe the qualitative research interview as a construction site of knowledge. An interview according to my understanding is literally an '*interview*', an interchange of views between two persons conversing about a theme of mutual interest. The interview was designed as an in-depth interview, which involves conducting intensive individual interviews with each participant to explore their perspectives on the issue under study. McMillan and Schumacher (2009) contend that the in-depth interview extends and formalises conversation, and is often referred to as a conversation with an objective.

McNamara (2009) contends that interviews are useful for getting the story behind a participant's experiences, where the interviewer can pursue in-depth information around the topic. The interviews may be useful as a follow-up to certain respondents' questionnaires to further investigate their responses and interviews. Seeking to unpack both factual and meaning levels through the latter was quite difficult. (Kvale & Brinkman, 2009).

A careful study of characteristics outlined by Kvale (2007), that a qualitative interview focuses on the everyday life of the interviewee, seeking the meaning of central themes in the daily life of the subject, through the use of normal language to obtain descriptions of specific situations and positions relative to the research questions and theoretical framework, made interviewing one of the appropriate data collection methods for this study.

The interview was conducted for approximately 90 minutes per participant, and was recorded with prior consent from the participants, and thereafter transcribed. The semi-structure interview served two purposes: Firstly to get clarity on responses from the questionnaire, and secondly to probe the answers deeper, to uncover issues relevant to the research subject.

In order to probe the issue under investigation, the interview agenda was structured as illustrated in figure 3.6 below.



**Figure 3.6: Interview protocol**

Standardised, open-ended interview questions were used, so mostly the same questions were asked of all the interviewees that fell into the same case, though some follow-up questions differed. This approach was chosen because it facilitated faster interviews that could be more easily analysed and compared. Secondly, the participants had the opportunity to answer the questions; however they chose to respond, allowing in-depth responses to be obtained, along with a description or an explanation.

The interviews were conducted on a semi-structured basis, guided by a schedule of questions and issues (Appendix G: pg. 255 & H: pg. 256); these were flexibly structured, which allowed data to be captured in their natural form. Also, because the interviews were one-to-one, the researcher had the opportunity to build a good relationship with the participants that enabled a free disclosure of their experiences and perspectives.

### **3.10.3.1 The Interview Setting**

The interview was conducted in the photographic physics laboratory of the Department of Mathematics, Science and Technology Education (DMSTE). The venue is well-padded and devoid of external noise and intrusion. The interviewees and interviewer had their telephones switched off throughout the duration of the

interview. There was a well-protected environment conducive to a friendly interaction with the participants in order to achieve the desired objectives.

### **3.10.3.2 The Interview Schedule**

In this study, the participants were interviewed individually, in their spare time, when they felt it was convenient to concentrate on the process. Hence, the interview schedule with each participant was negotiated at their convenience, and considering their responsibilities (Appendix L: pg. 296). However, all the interviews took place between ten in the morning and four in the afternoon. They generated a large volume of information.

### **3.10.3.3 The Interview Questions (Appendix G: pg. 255 & H: pg. 256)**

The interview questions were twofold and categorised as A and B.

The category A questions varied from interviewee to interviewee, since they were mainly a follow-up of issues that arose from the questionnaire, that required clarity.

The second category, B, consisted of standard, open-ended questions where the same questions were asked of the interviewees. However, there were follow-up questions to responses in cases where there was ambiguity on issues raised. The questions focused mainly on the research questions and followed the ICT development stages described in chapter 2. They were structured according to Stewart and Shamdasani's principles cited in Gill, et al. (2008), that interview questions should move from general to more specific, and the order should be relative to the importance of the issues in the research

This type of interviewing allows the participants to tell their story and express themselves beyond the questions asked. The expectation was to obtain an in-depth understanding of how the participants engage with ICTs in their teaching and learning.

To avoid any inconsistency and to test the effectiveness of the recording instrument, rehearsals with pre-test non-participants were conducted. To minimize bias, a digital audio recording device was used and the services of a professional transcriber employed.

#### **3.10.3.4 Handling the Interview Data**

The handling of the interview data started with the transcription. According to Davidson (2009), transcription of an interview is a practice in qualitative research and provides an important source of information. The recorded interview, after transcription, produced approximately a 180 page document for analysis.

There were 110 pages of raw data from the students' source, while 79 pages came from the lecturers' source. The transcription was done, using digital software. The transcribed data was read through several times in order to build theoretical sensitivity (Strauss & Corbin, 1990). Secondly, it provided a unique opportunity to criticize the data.

To achieve the goals of analysis, the data was scrutinised to identify commonalities which led to categorisation and reduction. To reduce the transcribed data, I had to get familiar with it by listening to the recorded version while reading through the transcript, thinking about the content and focusing it on the domain of the research questions (Hesse-Biber, 2012). The reduced data is attached (Appendices J: pg. 280 & K: pg. 281)

#### **3.10.4 Document Analysis**

Interviews and questionnaires were used as the researcher's main data collection techniques, though when transcribed and converted into written form, these eventually became documents. In this study, it was vital that the voices and views of the students and lecturers be heard. It was most unlikely that existing documents would be a reservoir or conduit for these voices and views. Therefore, the researcher made questionnaires and interviews the primary data collection methods. However, policy documents on ICT integration in education, at national and institutional levels were relevant and thus served as additional sources of information.

According to Prior (2003:4), "In most social scientific research, documents are placed at the margins of consideration". Yet, as articulated by Weber (1978 cited in Owen, 2013), the modern world is made through writing and documentation. Corbin and Strauss (2008) argued that document analysis, like any other analytical methods

in qualitative research, requires data to be examined and interpreted in order to elicit meaning, gain understanding, and develop empirical knowledge.

Bowen (2009) contends that documents provide background and historical insight that helps researchers to understand the historical roots of specific issues, and can indicate the conditions that impinge upon the phenomena currently under study. In this respect, the researcher used information drawn from the documents to contextualise data collected from the questionnaires and interviews. Furthermore, the documents, though secondary data collection technique, provided supplementary research data. Therefore, information and insight derived from the national and institutional ICT documents were valuable additions to the researcher's knowledge base.

In this research, objective analysis of information conveyed in the policy documents on ICT at both levels (national and institutional) was accomplished by means of the explicit application of rules, the researcher called 'criteria of selection', and was established before the collection of the actual data from the primary sources. In this regard, the researcher focused on identifying pertinent information relative to ICT integration, and separated it from that which was not pertinent (Corbin & Strauss, 2008).

In sum, the documents provided background and context, and served as supplementary data source in the study.

### **3.11 DATA ANALYSIS**

In this section, the researcher discusses the data analysis process.

Data analysis is the process of developing understanding, and making sense and meaning from the data collected in the study (Merriam, 2009). In the analysis process, data is made manageable by collating it into categories, interpreting it, determining important information, and identifying recurring patterns that emerge (Marshall & Rossman, 1999).

By examining the information collected from different methods, the emerging themes were identified, and the findings corroborated across the data set to reduce the

impact of potential biases. The researcher also identified categories, ideas, views, roles etc. in the data with the aim of identifying commonly shared reasoning.

Prior to the distribution of the questionnaire, and the interview session, the respondents were briefed on the nature of the study, my expectations of them and my responsibilities as the researcher. Again, before the interview, the researcher engaged the respondents and explained the purpose of the interview, the focused questions that were to be addressed, and assured them of absolute confidentiality.

The researcher self-administered questionnaires to fifteen participants and received eleven back, as mentioned earlier. The first task was to code and extract quotes corresponding to all the issues to be addressed, and further identify themes that emerged. Secondly, the researcher identified responses that required clarification in the interview session, and also identified issues not addressed in the questionnaire, but relevant to the research. The data was then examined and holistically interpreted in order to elicit meaning, gain understanding and develop empirical knowledge.

The interviews were semi-structured, tape-recorded and transcribed by the researcher and one other professional transcriber engaged by the researcher. The transcriptions were checked and re-checked for precision, and in the process the researcher became familiar with the data for easy inductive analysis.

A thorough, systematic review of the national and institutional ICT policy documents provided background information that helped the researcher understand the sociocultural, political, and economic context in which ICT is being integrated into teaching and learning. Information contained in these documents, though scanty on integration framework, suggested events or situations that were interrogated. Therefore, though incomplete and salient on issues investigated, the reviewed documents augmented the questionnaire, and interview data thus served a useful purpose. Hence, they concur with Bowen's (2009) assertion on document analysis with other data gathering techniques.

The researcher's data analysis technique through the lens of a constructivist, involved descriptive and evaluative coding of the questionnaire and interview

transcript, and relevant documents associated with policy on ICT integration. Using the developed conceptual framework as an initial starting point, and Atlas. ti 7 as a supplementary tool, the data was organised and coded. The qualitative research software (Atlas.ti 7) was helpful in manipulating data. However, a large element of researcher interpretation was dominant.

In summing up, a comparative approach was used to identify recurring regularities and patterns in the data to assign the information into categories.

### **3.12 RESEARCH RIGOUR**

Rigour in qualitative research is concerned with the ability to determine if the conclusions drawn by the researcher are trustworthy.

A number of frameworks have been put forward (and debated) in the literature on qualitative inquiry; however, a widely adopted set of criteria has been that proposed by Lincoln and Guba (2008). These frameworks have replaced the concepts of reliability and validity with that of *trustworthiness*. Rather than criteria of *internal validity*, *external validity*, *reliability* and *objectivity* which are typically used to establish trustworthiness within a quantitative research paradigm, they originally proposed that research using qualitative methods, such as this study, should consider the criteria of *credibility*, *transferability*, *dependability* and *confirmability*. In response to their critics, they later expanded these criteria to include that of *authenticity* (Guba & Lincoln, 2005; Lincoln & Guba, 2008).

Researching pedagogical integration, epistemological views, ontological assumptions, innovation and creativity, cognition and conceptual understanding, using ICT, requires all the elements of trustworthiness.

To address *credibility*, the researcher used three data collection tools, namely, questionnaires, interviews (verbal) and field notes, to generate three layers of data for each of the participants, thereby involving the cross-checking of information from different dimensions to confirm the appropriateness of the data and enhance

saturation. This conforms to O'Donoghue and Punch's (2003:78) view of "triangulation as a method of cross-checking data from multiple sources to search for regularities in the research data". Altrichter, Feldman, Posch & Somekh, (2008:147) expressed a similar view that "triangulation gives a more detailed and balanced picture of a situation".

Secondly, the questionnaire was a handwritten response, and the interview audio was recorded and transcribed. For the purpose of validating the data, "member checking" was adopted. This allowed each participant to review the transcribed interview to ascertain its accuracy and congruency, with comments added. Similarly, the captured questionnaire response was given, together with the raw data, to the participants for authentication. The documents used for "member checking" were available upon request.

Thirdly, the researcher engaged with the data over a period of time and applied constant comparative methods, whereby the findings were continuously checked and compared to minimise the possibility of personal values creeping into the interpretation of data (see appendixes B: pg. 220; D: pg. 238; F: pg. 253 & H: pg. 256). The researcher critically did introspection (reflexivity) on a regular basis to avoid any bias or inclination that might have influenced any conclusions about the data.

In the context of Guba and Lincoln's (1994) *transferability*, this has to do with the application of findings in one context to another context or "setting". To ensure transferability of the study, the researcher ensured a thick description of ICT integration, as well as the role of pedagogy, in the integration process, with the participants voluntarily providing information on their practice.

Several of the data analysis documents used to generate answers to the research questions have been included in the thesis (see appendixes A: pg. 216; C: pg. 234; E: pg. 250 & G: pg. 255). Access to these documents will give other researchers the opportunity to transfer conclusions of this study to other cases or similar inquiries.

*Dependability* in a qualitative study like this one has to do with the stability or consistency of the research process over a period of time. The participants were given adequate time to respond to the questionnaire with regular reminders, and

assurances of flexibility of the collection period. A three week information notice was given to the participants before the interview, to ensure their preparedness. Responses to the questionnaire were collected at the participants' convenience, but within the discussed timeframe. The interview data, as well as the captured responses to the questionnaire (see appendixes B: pg. 220; D: pg. 238; F: pg. 250 & H: pg. 256) and the field notes, present a meticulous approach to the study.

The discussion of how the participants were selected, the interview schedule and questionnaire administered, provide evidence of dependability.

According to Guba and Lincoln (2005), Lincoln and Guba (2008), *confirmability* refers to the quality of the results. In discussing the findings of the study, reference is made to researchers whose findings corroborate this one. In other cases reference is made to literature and sometimes to the data analysis chapter. Secondly, my supervisors are experienced in research and went through the document, provided guidance and scrutinised every step of the research process. Furthermore, the researcher discussed the interpretations and conclusions of the findings with a peer (Patton, 2002). The peer who showed interest in the research and was familiar with contemporary theory methodology and qualitative research, gave an in-depth opinion about the data.

Lastly, the criterion of selection used in the document analysis was sufficiently exhaustive, and thus accounted for any variation of information content. This was done to provide rigid and consistent comparable results if applied by other researchers, if reviewing the same information.

### **3.13 LIMITATIONS**

One perceived limitation of qualitative research is its lack of transparency (Bryman & Bell, 2011) in that it is difficult to see how the researcher might reach conclusions. To address this weakness, data collection methods were meticulously scrutinised, tested and errors rectified, followed by a careful analysis of the data obtained.

The words used in constructing the questionnaire, interview questions and discussions, were kept plain and simple as the researcher noticed that some of the student participants had a problem in expressing themselves clearly in English. The researcher perceived could be an inhibiting factor, as they could have been misinterpreted. To minimize this factor, transcripts of the interview and the captured responses to the questionnaire were given to the respondents for authentication.

The respondents, without noticing, used particular words to express their ideas on their attitude towards ICT integration. Field notes taken during the interview sessions, which, when expressed in the body language and facial expressions of the respondents, contributed positively to clarifying messages that were carried across.

The research focused on the practices of the participants who were the researchers' students and colleagues, as there was fear that they might withhold information to protect their practices and credibility. However, with constant assurances of anonymity and confidentiality, they opened up and freely discussed their perceptions, ideas and practices.

### **3.14 ETHICAL CONSIDERATIONS**

This section discusses the handling of ethical issues during and after the research. There are several reasons why it is important to adhere to ethical norms in research. These include: promoting the aims of the research, such as knowledge and truth, and also, promoting the values that are essential to collaborative work; moral and social values, such as trust, mutual respect, fairness, social responsibility and human rights (Shamoo & Resnik, 2009). Ethics are generally considered to deal with beliefs about what is wrong or right, good or bad (McMillan & Schumacher, 2009). However, Wassenaar (2006) claims that one of the most important aims of research ethics is to protect the welfare of the research participants.

In doing this research the philosophical principles guiding ethical research were observed as closely as possible. Wassenaar (2006:67–68) mentions four basic principles applicable to research, namely, autonomy and respect for dignity of persons, non-maleficence, beneficence and justice. In addition to Wassenaar's

proposed guidelines, other researchers' views were also used to guide the researchers' ethical conduct in this project.

The research approach was based on human interaction; therefore these measures were taken in planning and executing the study to protect the stakeholders and participants.

### **3.14.1 Dignity of Stakeholders and Participants**

There was a thorough discussion on the purpose, goal and aims of the study with the different stakeholders within the study, including the participants (Ary, Jacobs & Razavieh, 2002; Denzin & Lincoln, 2002). Ethical clearance was obtained from the two institutions involved in the research, by following all the necessary protocols, and hence, clearance and gate-keeping authorisation was obtained.

Integrity was promoted by being honest and fair, keeping to promises and agreements, acting with sincerity, striving for consistency of thought and action and under no circumstances was the dignity of the participants compromised (Wester, 2011; Shamoo & Resnik, 2009).

### **3.14.2 Confidentiality and anonymity**

Information obtained from participants was treated with absolute confidentiality and will be kept as such at all times (Denzin & Lincoln, 2000; Shamoo & Resnik, 2009). The participants were informed that information provided was to be securely stored for five years, after which it will be destroyed and electronic records deleted.

Participants were treated with respect. Clear and understandable verbal and written communication was issued with factual data taking into consideration emotional and cultural values.

Collecting data was anonymous and confidential because no names or identities could be linked to the findings and reports (McMillan & Schumacher, 2009; Denzin & Lincoln, 2000).

### **3.14.3 Voluntary Participation**

Informed voluntary consent issued by the institutions and the researcher were received from each participant before the questionnaire distribution, as well as before the interview session (Bryman & Bell, 2007). The consent forms explained clearly that their participation was purely voluntary and that participants were free to withdraw at any point (see appendixes Q: pg. 300).

### **3.14.4 Non-maleficence**

This includes deception, such as deliberately withholding of information, misinterpretations of facts and misrepresentation of issues. In this study, no misinformation occurred and there was transparency at all times. In addition, the researcher kept regular communication links with all involved in the study, updating them on progress made, such as reporting of data, results, methods and procedures and any publication to be made (Shamoo & Resnik, 2009; Denzin & Lincoln, 2000, Wester, 2011).

### **3.14.5 Beneficence**

The study posed no physical, emotional or psychological discomfort to any of the participants (McMillan & Schumacher, 2001). Questions that could lead to emotional distress, anxiety and harassment were avoided. The interview setting posed no danger or exposure to public viewing, and so protected the participants from external distress.

Absolute care was taken when disseminating findings, with special attention paid to accuracy. Adequate feedback was provided to the participants on the research results, as a form of recognition, acknowledgement and gratitude for their participation (Denzin & Lincoln, 2000).

The study adhered to the ethical considerations outlined by the two institutions involved in the research.

### **3.15 SUMMARY**

This chapter examined the philosophical assumptions, research design and methodology used in the study. The researcher debated why a particular design, approach and method best suited this study. The chapter began with a discussion of the basic assumptions that underlined the study and continued with a paradigm and clear distinction made between approaches in qualitative research. Studying the issue within a real-life context (Yin, 2003) provided adequate justification for positioning the study as a case study research, and the data analysis followed the dictates of a case study approach.

This chapter also included a section on the use of a triangulation approach which provided different perspectives on the same data from different data sources, and strategies adopted to ensure trustworthiness. Limitations and ethical considerations were also discussed.

The next chapter is a presentation and comprehensive analysis of data from the questionnaires and interviews obtained from the respondents.

## CHAPTER 4

### DATA PRESENTATION AND ANALYSIS

#### 4. INTRODUCTION

Chapter 3 reported on the methodology, the paradigm that shaped the study, the population and sampling procedures and selection. It also included a discussion of the research approach, as well as a justification of the qualitative framework as the appropriate choice for collecting data. This chapter presents and analyses the data collected by means of the questionnaire and interviews, covering the two cases mentioned in the previous chapter. The open-ended questionnaire was structured in three sections, namely, socio-demographic characteristics, knowledge, and effective use of ICT resources provided by the institution and the pedagogical integration of ICT in curriculum delivery for conceptual understanding, skill development and quality teaching and learning in ITE. The in-depth interview further probed the use of ICT to advance knowledge and skill development as essential components of integrating ICTs in the current digital environment. Furthermore, it served as a follow-up for clarification to responses in the questionnaire, and questioned the effective and efficient use of ICT in ITE, with the aim of addressing the research question. The data obtained through the interview process was integrated with the questionnaire data and from documents, and analysed thoroughly.

In order to do a careful analysis and obtain an in-depth understanding of lecturers' pedagogical integration of ICT in mathematics, science and technology education curriculum delivery, the main question was sub-divided. The researcher started this chapter with a brief presentation of the demographic characteristics of the people who participated in the study. This is followed by a sequential presentation and analysis of themes that address the respective sub-questions outlined in chapter 3.

#### 4.1 DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

Participants' approach towards the pedagogical integration of ICTs is shaped by their socio-demographic characteristics. The data revealed that most of the lecturers were born before the emergence of advanced digital technology, as opposed to their

student counterparts. Therefore, lecturers found it difficult to depart from the traditional structure of teaching and learning.

Analysis of participants' background, academic status and social standing provides a fair reflection of how these factors impact on their attitude to using ICT in teaching and learning.

A total of 11 participants returned the questionnaire distributed to fifteen targeted participants (as described in chapter 3) and were subsequently interviewed. The 11 participants comprised 4 lecturers, 1 information technology staff (an education technologist) and 6 students. However, for an in-depth analysis of their responses, comments and views, it is important to present a brief overview of the demographic characteristics of the participants, which include their highest qualifications, subject specifics, gender, and school background, amongst others. The demographic characteristics distribution of participants is shown in the tables below.

**Table 4.1: Distribution of lecturer and IT participants by highest qualifications and gender**

Participant	Highest qualification	Gender
L1	BSc	Female
L2	MEd	Male
L3	PhD	Male
L4	PhD	Male
IT1	BSc	Male

It can be seen from table 4.1 that the participating lecturers in the research have the highest qualifications, ranging from first degree to a doctoral degree. One lecturer participant holds a Bachelor of Science degree and is currently busy reading for the master's qualification; one holds a master's degree in technology education, whilst the other two are in possession of doctoral degrees. All the participants are involved in teaching mathematics, technology or science education at the ITE department of the institution. The IT participant holds a Bachelor of Science degree and is studying

towards a master's degree. The male dominated participation of the lecturers projected in the table is a reflection of the male gender dominance in ITE in the institution. Secondly, the few female lecturers in the department were not very willing to participate in the study.

**Table 4.2: Data projecting lecturer and IT participants by years of ITE teaching experience and subject specifics**

Participant	ITE teaching experience	Subject specific teaching
L1	5	Physics
L2	5	Mathematic & Technology Education
L3	5	Mathematics & Technology Education
L4	6	Chemistry
IT1	4	Educational technologist

The lecturer participants have been with the institution, or more precisely with the Department of Mathematics, Science and Technology Education (DMSTE), training teachers in mathematics, science or technology for more than four years.

Table 4.2 reflects the wealth of experience the lecturers and IT participants have, and the subject areas they are teaching. It is noticeable from the table that the lecturers have been teaching their respective subjects for a considerable time and should be very familiar with the curriculum. The IT participant renders technology support service to both lecturers and students through organising short courses and workshops, and he also provides on-site technical support for the effective use of ICTs in teaching and learning.

The researcher in the next table presents the lecturers and IT personnels' institutional responsibilities, as well as their school information.

**Table 4.3: Presenting lecturer participants by ITE levels currently being taught, IT personnel current levels of engagement, and their initial school background**

Participant	Levels teaching	Initial school background
L1	1 & 4	Township
L2	2, 4 & Honours	Rural
L3	1, 3 & Masters	Semi-rural
L4	4, Honours & Masters	Semi-urban
IT1	Staff and students IT development	Rural

The IT personnel is mainly involved with student and staff technology development and skill acquisition. The table (4.3) above illuminates their school education background, of which four of the above participants went through rural and township schools where ICT facilities were non-existent. One participant went through the ‘House of Delegates’ educational system with very limited ICT resources. Therefore, the school education and subsequent training they underwent, as well as their socio-cultural orientation, plays an important role in the transition from product to scenario, and in implementing technology in the classroom.

The table further depicts the current levels of ITE in which the lecturers are engaged. A detailed breakdown of some of their lecturing responsibilities is as enumerated:

**L1:** “*Physics for BSc. extended degree programme (BSc. EDP); a course or two in Physical Science for educators (Physics section)*”.

**L2:** “*Method technology for Educators 3 & 4; Technology for Educators 4 and postgraduate*”.

**L3:** “*Method of Physical Science; Physical Science for educators and postgraduate*”.

And **L4:** “*Technology Education 1 & 3 including Honours*”.

It is evident that all the lecturer participants are involved with a group of final year students each academic year, and are supposed to acquire the value added role of

ICTs in their curriculum delivery. Moreover, they are also involved in student supervision at practice teaching level, as well as postgraduate supervision (with the exception of L1), notwithstanding designing and implementing teaching materials.

The following table illuminates the student participants' highest qualification and major subjects.

**Table 4.4: Data presenting student participants highest qualification and subject majors**

Participant	Highest qualification	Subject majors
S1	PGCE	Physical Sciences & Mathematics
S2	B.Ed. (SPF)	Physical Sciences & Technology
S3	B.Ed. (SPF)	Physical Sciences & Mathematics
S4	B.Ed. (SPF)	Physical Sciences & Technology
S5	B.Ed. (SPF)	Physical Sciences & Mathematics
S6	B.Ed. (SPF)	Physical Sciences & Mathematics

Table 4.4 outlines the students' prospective highest qualifications, ranging from a bachelor's degree to post graduate certificate in education. Five of the participants are currently in their final year of the B.Ed.Senior Phase and Further Education and Training Phase (SPF) programme, whilst the sixth has a postgraduate certificate in education student. The table also shows that the student teachers read two of these subjects; mathematics, science and technology in education, as majors, preparing them for the classroom.

It is important to present the student participants' level at ITE and provide evidence of their duration in the institution. This is shown in Table 4.5.

**Table 4.5: Distribution of student participants by level at ITE, and the number of years in tertiary institution**

Participant	Level	Number of years in tertiary institution
S1	4	4
S2	4	6
S3	4	5
S4	4	4
S5	4	4
S6	4	4

The B.Ed. (SPF) is a four year programme, and it can be seen from the table that two-thirds of the student participants entered straight into the tertiary institution from matric, whilst one-third went elsewhere before joining the stream. Although S1 spent four years in the institution, he started with pure natural sciences, majoring in Mathematics and Physical Sciences before enrolling for the postgraduate certificate programme in education. S2 studied “..... *computer literacy and PC engineering diploma from certain FET college January 2008 – December 2008...*” so spent two more years than the others in the tertiary environment, whilst S4 studied Computer Science for one year at another university before enrolling for education studies.

Table 4.6 below shows the importance attached to gender in considering the participants in the study, and the relevance of students’ school education environment.

**Table 4.6: Student participants' gender and school education environment**

Participant	Gender	School education environment
S1	Male	Rural
S2	Female	Rural
S3	Male	Rural
S4	Male	Rural
S5	Male	Rural
S6	Male	Rural

The above table reflects the gender disparity in the field of mathematics and science in the B.Ed. (SPF) programme. The table also shows their school education environment indicating that the participating student teachers are from rural schools with limited ICT infrastructure. They encountered basic ICT devices for the first time in the tertiary environment.

The demographic characteristics of the participants described showed the rich experience of the lecturers when it comes to their exposure to mathematics, science and technology education curriculum, though this may not necessarily translate into quality and inventive teaching. The students have been in the institution, and the majority in ITE programme, for at least four years. Therefore, they are familiar with the approaches used by the lecturers to deliver modules, notwithstanding their exposure to resources provided by the institution. It was apparent that all the participants had a similar initial school background. It further spelt out the academic qualifications of the lecturer participants and the prospective qualifications of the students, making them valuable participants in this project.

## **4.2 HOW IS ICT INTEGRATED IN THE TEACHING AND LEARNING OF MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION (MSTE)?**

This section presents the data on the integration of ICT into teaching and learning of MSTe starting with a brief overview of what is meant by effective integration. This is followed by the use of technology in teaching, and usage by the students in learning, which includes the identification of productivity tools and facilitation with ICTs.

### **4.2.1 Overview**

Societies have become Information and Communication Technology dependent for optimal functioning. To prepare students for the 21<sup>st</sup> century knowledge, society requires a transformed education that fosters the development of 21<sup>st</sup> century skills for the work environment. To effectively transform education calls for strategies and initiatives with appropriate mechanisms and resources to accomplish the dictates of the changing platform. ICTs seem to provide the necessary solution for lecturers and students to meet these changing demands, including the teacher training programme. Thus, to prepare teachers for the school and the changing landscape in education requires effective and efficient integration of technology in the ITE curriculum.

Integration of ICT in this context occurs when technology is effectively used as a facilitating instrument (as elaborated in sections 4.2.1 and 4.2.2 below) in conjunction with existing conventional curriculum delivery approaches for knowledge construction and skill development, through quality teaching and learning. Literature revealed that continuing ICT integration has had a tremendous impact on education (Becta, 2008; Jimoyiannis & Komis, 2007), and has revolutionized and transformed teaching and learning from teacher-centeredness to a student-oriented teaching approach (Becta, 2008; Wang & Woo, 2007).

This shift in emphasis from the lecturer to the student means that the entire way in which the university curriculum is structured has to be changed, to enable students to be at the centre of, and more involved in, their own learning. The curriculum should be designed to stress active involvement rooted in constructivism, focusing on a conceptual framework for technology-based teaching and learning. The curriculum must set out the knowledge, understanding and skills needed for life and

work in the 21<sup>st</sup> century, establishing common standards and high expectations of achievement, harnessing the learning platform and enabling students to function in the current digital environment.

With a crafted vision and mission statement and a well-articulated 'egg metaphor' conceptual framework of the institutions' ITE section and a departmental (DMSTE) agenda for the incorporation of ICTs in programmes and course delivery, it is essential to design a curriculum to address these profiles.

It is interesting to note that the mathematics, science and technology education curriculum has been structured to encourage integration of ICTs which is regularly talked about at departmental meetings, but in most cases seems to 'fall on deaf ears'. One lecturer participant, on realising that ICT is not integrated, relegated it to a section which may enforce all teacher trainers to adopt technology in curriculum delivery. This is evident in the comment:

*"I could hardly see the type line, because in our meetings we talk about incorporating ICT in our programmes in a way that there will be ICT in the form of a section, which will enhance this other section" (L2).*

Seemingly, a range of physical and material support needed for the successful implementation of such a holistic curriculum requires lecturers' and students' ICT competencies and skills and their integration for comprehensive achievement. To further explore this, the presentation and analysis below depicts the manner in which lecturers and students engage with ICT in the curriculum structure.

#### **4.2.2 ICT Usage in Teaching and Learning**

The pedagogical use of ICT in curriculum delivery does not depend only on good access to equipment or adequate technical skills, but also on competency in using ICTs. Some lecturers integrate the available ICT resources in their teaching process e.g. L2 prepared slides, or identified websites, and directed students to obtain further information, and in the preparation of module aids, used the internet, especially e-books for comprehensive facilitation. This is evident in the comment:

*“..... I cut some slides for presentation in class, identify some websites for students to search for more information and use the internet to access books that are on line to develop the content I deliver....” (L2)*

It is clear that some lecturers use ICTs to download relevant teaching and learning resources, and blend these with materials from books to update their knowledge for efficient curriculum delivery.

#### **4.2.2.1 Identifying emerging ICT productivity tools for teaching**

The learning paradigm discussed in chapter 2 confirms that the purpose of ITE is not to transfer knowledge, but to create environments, including identifying tools and experiences that bring students to discover and construct knowledge for themselves. Lecturers must become members of the communities of learners that make discoveries and solve problems, and recognise that the principal agent in the process is the student. Lecturers need to identify appropriate ICT productivity tools for teaching, and effectively use them to strengthen students' capabilities. They must make use of these tools and their relevance for mathematics, science and technology education to make teaching and learning these subjects an engaging, active process connected to real life and lifelong adventure. It must be emphasised that the productivity tools on their own will not bring about desired improvements in the quality of curriculum delivery, but changing the mind-set to use them reflectively, strategically and creatively, and contextualised appropriation of the tools will deepen the teaching and learning process.

The respondents acknowledge the important role the 'Blackboard' service contributes towards teaching and learning, however, the structure and design of the service does not actively encourage students in knowledge construction that reflects their understanding, comprehension and conception of information in mathematics, science and technology education. The participants seem to use the Blackboard at operating level 1 such as for loading information and testing.

IT1 believes that Blackboard as a technology tool goes a long way to simplifying teaching and making teaching available to students and lecturers, and in essence has transformed teaching and learning in the institution. Furthermore, he commended the positive attitude displayed by the beneficiaries, but cautioned that

some lecturers are against change and thus, hold on to their traditional way of teaching. This is evident in the comment:

*“...immediately after I managed to convince one lecture and he uses the management system with his group or a group of students, those group of students will be able to tell their friends. And their friends, you will find that most of the time, the students who are not using ‘Blackboard’ are the one who are begging the lecturers why are you not using ‘Blackboard’...”*  
(IT1)

Another tool identified by the participants is computer technologies. The lecturer respondents claim that the modules and teaching materials designed considered computer technologies for information acquisition and dissemination of information. However, the technologies are not being used in teaching these subject domains and thus, do not engage students in a reflective and critical thinking process about issues and concepts being learnt.

The participants also identified cell phones as valuable tools in interacting with students. As one respondent commented:

*“Mostly the cell phone is for internet and for communication, for example if there is something I don’t understand concerning what I am doing in class, I use the cell phone to consult my fellow classmates or go through the internet and make research and try to get related information concerning those issues” (S1).*

However, this interaction is mostly on social issues, such as communicating assignment due dates, sending websites as references for tasks given, and for notifications. The students’ response does not indicate whether they lack knowledge of the effective use of cell phones as an academic interactive technology device and for collaborative learning.

It was clear from the participants’ responses that the tools identified were not used as cognitive tools, where learning takes place with technologies, but rather from the technologies. It is important for lecturers in ITE to be able to design ICT-based knowledge communication and to use ICT to support the development of students’ knowledge creation skills to increase the understanding associated with effective implementation strategies, as well as their self-efficacy with ICT competencies, accompanied by reflective learning. However, this seems to be a distant dream, as one of the lecturer respondents reflected in the comment:

*“... Okay, now if you remember quite well on my response I said I don't use those often.”*

(L1)

This was L1's response when asked about engaging other ICT tools and devices like cell phones, the internet, the computer, the data projectors and other digital or non-digital media, apart from the 'Blackboard'.

L1 further contended

*“... difficult to conceptualise kind of topics, textbooks refer you to the internet where you can just go there and have an animation of what is happening and it is explained...”*

but seemed not to engage with the students in achieving the necessary skills required to go through the process for maximum conceptualisation.

On the other hand, identifying websites for students for further information is a way of contributing towards students' creativity development, as well as skilling them in the use of digital technology in teaching and learning, with the understanding that the students must amass the ability to integrate ICT in their teaching endeavours, even though resources are insufficient. This is evident in the comment:

*“...there are not enough resources in our teaching setup, what I normally do are I cut some slides for presentation in their class so to enforce that they need to be participative too. What I do is I identify some websites to go and search for more information based on what we discussed in class” (L2).*

The lecturer demonstrated an approach of pedagogical integration of technology in curriculum delivery. However, sending students to seek more information from websites and other technology environments, without demonstrating adequate strategies of monitoring the effectiveness of this approach, may be just a theoretical ICT skilling.

It is important for lecturers to ground the use of technologies such as net world devices, digital resources and electronic environments for the 21<sup>st</sup> century skills, like constructing knowledge, creativity, innovation, critical thinking, problem solving, learning to learn, metacognition, collaborative learning and skills development by students, through facilitating with ICTs. This is evident in L2's comment:

*“... ICT is the way of teaching in our future, because all those things that we are doing, like you can check here, people are still using chalkboards and this stuff. Those things are outdated. So the backbone of teaching, the way of teaching in this 21<sup>st</sup> century it is ICT...”*  
(L2)

The lecturers acknowledged the valuable role of ICT when integrated into teaching and learning, and the need to break away from the traditional dominance of teacher-centeredness hence, the relevance of employing technology in advancing teaching and learning in the new digital learning space.

Discussion forums were another emerging strategy that could influence teacher trainers' pedagogical integration of digital technology in teaching and learning. However, collaborative use of ICT among teacher trainers does not exist, as L2 stressed: *“...in most cases we don't have such forums ... rather each uses it his/her own way”* which showed that students are not challenged or motivated to engage with these resources and to share knowledge.

#### **4.2.2.2 Facilitating with ICTs**

Lecturers' technical knowledge and competency contributes to transforming the way in which ICT is used in teaching and learning, and is a driver towards developing teacher trainee competencies in the effective use of ICTs in the classrooms. The respondents agreed in this regard, though limited this to the use of computers.

All the respondents described their experience with ICTs. Respondent (L2) indicated the role of computers and internet in the preparation of course materials and accessing resources and relevant journal articles for teaching and learning, as expressed:

*I use the internet, access the departmental policy documents and in developing my teaching resources at the same time get the books that are on line on the content”* (L2).

This is one illustration of how some lecturers make use of ICTs to approach curriculum delivery.

Another respondent, L3, accentuated the importance of technology in advancing the delivery of course content.

*“The university has Wi-Fi connections in our block. I am able to access the internet in my class. Sometimes, lessons are conducted by accessing specific information on certain websites” (L3).*

Respondent four (L4), on the other hand, acknowledged the value of ICT in teaching, and expressed support for its use:

*“In the first world communities, it is realistic. I fully support it, but not yet ready to implement it in my subject(s). a lot still need to be done” (L4).*

However, L4 was of the opinion that ICTs are realistic in first world communities, but he is not ready to implement its use in teaching and learning, contending that a lot still needed to be done. He acknowledged the relevance of ICT in teaching and learning, but viewed its use in the classroom differently, due to his pedagogical orientation.

One valuable ICT initiative the university introduced to improve teaching and learning, as well as making lecturers accessible to students, is the “Blackboard” learning management service. The lecturers were asked to comment on the service, especially their take on, and experience of the service. Three of the participants expressed positive sentiments about the service. Respondents one, two and three had this to say:

**L1** *“Blackboard’ is a good tool for all stakeholders. It makes lecturing easy, marking multiple choice questions easy and accessing lecture notes etc. easy thus reduces paper work furthermore, makes communicating with students easy”.*

Though expressing such positive sentiments about the use of ICTs in facilitation, L1 still had not undergone any pedagogical re-orientation to appropriately integrate technology into subject matter delivery, saying:

*“No, it (Blackboard) has not changed my approach to teaching. It is just that for me it simplify things...”*

This was an indication of the lecturer holding onto the teacher-centred philosophy of teaching and learning.

The second respondent commended the initiative, commenting:

**L2:** *"It is a good initiative in that it gives an insight on how to engage your material with students on line".*

The same respondent expressed the use of the service to communicate the latest information on a subject which might not be in the teaching module, and also for students being able to download resources online in their own time.

Respondent three commented:

**L3:** *"I was trained on "Blackboard" together with colleagues in the school. A person from the company ("Blackboard") provided the training. Thereafter, the university's IT department provided follow-up training for lecturers. The follow-up training was opened to all lecturers. I believe that some of our new lecturers need to be trained on "Blackboard". The service offered on the campus is satisfactory".*

Further, L3 claimed that 'Blackboard' enabled a variety of resources to be made accessible to students, exposing them to e-books and videos, and could be used as discussion forums. Using the 'Blackboard' forum reduced printed matter, eventually contributing to a safer environment. Students could read information online and also get immediate feedback on assessment, therefore; through 'Blackboard' the student could always be in contact with the lecturer and classmates.

However, one respondent (L4) was not in tune with the service and claimed:

*"The service is good but our students still prefer contact sessions with lecturers"*

Thus, holding onto the traditional view, and assuming that students preferred direct interaction with lecturers rather than engaging with them electronically.

Another lecturer viewed the 'Blackboard' service as an 'instructional technology'; a medium to convey information and tutor students as reflected in the comment:

*"You know with ICT it is only for acquiring tutorials and questions and work sheets..."(L1)*

This demonstrated the participant's skewed knowledge of the potential benefits of the service as he (L1) could not imagine its contribution to maximising teaching and learning for understanding. Instead L1 holds on to the traditional philosophy of curriculum delivery.

To diffuse the view expressed above, one respondent stated clearly that the service could be used as a knowledge construction tool rather than having programmed tutors. This is evident in the comment:

*“...The problem I have with some other facilitators or people who are sort of tasked for academic support, they tend to use 30 % or 40 % of what they have in terms of the capacity of the system. Then explore it further. It is like having a Ferrari and you are driving normal speed. It is the problem I am having, that is why I am saying maybe if the ‘Blackboard’ can be expanded to a point whereby we sort of detect its full capacity, then you may have an interest to use it, but to me what I have seen now it is not different to e-mail, because I can send you an e-mail...” (L3)*

However, he contended that many lecturers perceived the ‘Blackboard’ system as a ‘cut and paste’ tool instead of it being used constructively in teaching for understanding. The respondent attributed this underutilisation of the system to inadequate capacity of the educational technologists tasked to provide the necessary knowledge required for the efficient use of the facility, and offering support to the university community.

Further, the respondents emphasised the need for the provision of systems and services that could be used as cognitive tools, and advocated a learning environment to be developed to facilitate critical thinking and a higher order of learning. Presently, they claim to use ICTs as information resources, performance support tools, information gathering tools, and mediation tools, and to some extent, as a cognitive tool to support learning.

Despite the claims made by most of the participants, that they used ICTs, one participant clearly mentioned outsourcing in terms of field visits as an avenue of empowering students and developing their knowledge base, though they did not subscribe to the use of digital technology in the course delivery, as evident in this illustration:

*“.....For acquiring skills I, this is what I did, I took them out on a field trip...”*

This comment positioned the lecturer in the group of ‘born before digital emergence’ (BBDE) and highlighted a limited knowledge of ICT skills development and the integrated curriculum delivery approach, though he demonstrated subject specific practical field experience as a dimension of conceptual development.

The ironic fact is that the same respondent actively admits and ascribes to the integration of digital technology in initial teacher education, and its influence on student teachers' implementation of technology in their teaching career, commenting:

*"We are moving forward and ICT is here with us and instead of moving back, it is improved by the day. So our children, whether we like it or not, our children are computer literate and they enjoy it and they would love to see it being used. So it is our life. It is our daily bread. I would encourage that it be used effectively and not just being used" (L1)*

And a reminder:

*"Now that it is the wish of the government that all schools have computers and these computers should be utilised effectively for the students" (L1).*

However, she did not reveal any pedagogical integration in curriculum delivery, though she was very aware of the importance attached to skilling student teachers with ICT knowledge and aptitude, to drive the government agenda of producing digital literate citizens, starting with the school system.

Translating skills to students could occur in a variety of ways, including demonstrations with audio visual and the multimedia in class. Lecturer respondent 3 claimed to use ICT devices to generate a creative lesson, and by doing so expected students to emulate this, using available tools, to be creative about their learning, as expressed in the illustration below:

*"...to be able to do something similar. Alright, or getting them to do right or using the technology that you have to be able to show them you know there is so much more that can enhance the creativity of your lessons" (L3).*

Using technology to develop a creative lesson and innovative teaching regularly, could stir students' interest and they could end up developing creative learning approaches and a mastery of such skills for their future endeavours.

Most of the lecturers' recognised the place of ICT in teaching and learning, as evident in one lecturer's comment:

*“I will promote ICT. I think it is.., we may be in denial or maybe we have not seen it yet, but eventually we will all migrate to this ICT...” (L4)*

This respondent saw the potential of ICTs, and revealed a curiosity to explore things further, thus demonstrated a culture of thinking, feeding on curiosity, as reflected:

*“The good thing about ICT is I think if more people within the society are using it, and then the internet aspect, where people can easily access internet, maybe if people subscribe it is the cheaper systems. I don’t know. Like I was saying, in the classroom if we are discussing something that we don’t have answers for, we can easily search on the spot and get answer to it. Again instilling the culture of thinking, because they won’t just rely on what they get if they want to explore further”. (L4)*

This is a demonstration of good understanding of ICTs, and when and how to use technology. However, most of the lecturers seemed reluctant to buy into the principle of using some of the tools to communicate curriculum, as reflected in this comment concerning their perception of the ICT resources:

*“Maybe if you can get to a point whereby the things like this WhatsApp thing, they get to a point whereby we can talk a lot about the teaching, and then you may go somewhere”. (L4)*

Making reference to a social network medium as a ‘WhatsApp’ thing indicates how distant the lecturer is from engaging social media in teaching and learning. Substantial education is required to change such mind sets. n

### **4.2.3 Students ICT Usage**

Students constitute a significant group within this social system, and as such their perspective plays an important part in determining lecturers’ effective pedagogical integration of ICTs in curriculum delivery. Students’ effective use of ICTs in learning depends largely on their personal ICT skills development, notwithstanding the contributions made by their lecturers and the institution.

Regular engagement and productive use of ICT with understanding contributes immensely towards effective realisation of the transformational role these resources play in the teaching and learning process. This is evident in the following comment:

**S1:** *Always when trying to understand particular concepts, ICTs are used as an option in assisting you to understand that concept by browsing the internet to get additional information that can explain to you the concept from different angles.*

Many student participants expressed the same sentiment, and admitted that using ICTs helped them get through the curriculum with some ease, by getting extra information to support what they learned, as evident in the excerpt:

**S3:** *After every lesson, I would visit different websites on the internet to check for additional information concerning the subject matter and also visit tutorials websites in order to extend on what the teacher or the lecturer have done in class. Tutorials will help me to monitor my progress and also check where I'm lacking and need to improve".*

Furthermore, they claimed it saved time, motivated learning and added value to the learning process, as illustrated below:

**S5:** *"....ICT is time saving with respect to my studies as well as being attached to the world".*

Above all, when used properly, ICT encouraged conceptual learning, added authenticity and made mathematics, science and technology more credible, and lastly it contributed to ICT skill development, as indicated in the excerpt:

**S3:** *"It makes it easy or possible to cater for all different learners in the same time or lesson. It makes learning mathematics to be fast. E.g. Computer software are working very fast and advanced calculators can do complex calculations and different mathematical representations".*

#### **4.2.3.1 Identifying emerging ICT productivity tools for learning**

The starting point of engaging ICTs in the contrastive learning process is the identification of the appropriate tools that support learning and enhance conceptual understanding, while not ignoring skills development that accompanies the use of such tools. In the institution where the research was conducted, students are exposed to very few of the many diverse ICT devices mentioned in chapter 2. In order to improve the use of ICTs in learning, the institution introduced a 'Blackboard' service- a learning management system- as an interactive teaching and learning medium intended to facilitate regular interaction between students and lecturers.

When talking about ICT resources, the students' focus included the use of computers, data projectors, overhead projectors, cell phones and the internet.

Though a few expressed their exposure to different technology resources, many seem to have very limited exposure. A participant commented:

*“I started using computer in 2004, during my high school days. I studied computer literacy as a module in the BEd programme. I have also worked at the university computer labs for a period of two years (2010 and 2011) as a general computer lab assistant”. (S4).*

The following participant, who had spent a good deal of time working with ICTs, acknowledged the value-added nature of it and its potential for advancing learning for conceptual development and understanding. Student participant 2 had this to say:

**S2:** *With ICT I am having a little experience, before coming to the university. I have studied computer literacy and PC engineering in FET College so when I came here I was having an idea about computer and its applications.*

This participant expressed her ability to use ICTs, though not proficiently, but with some level of knowledge from her previous background. However, she acknowledged not having any knowledge about the ‘Blackboard’ system when questioned about it.

Contrary to this, participant 3 had no interaction with ICT facilities before entering the tertiary environment, as illustrated below:

**S3:** *“I started experiencing ICT in this institution, because during my primary and secondary level the only resources that were being used are textbooks and calculators. I started to experience more of it in this institution. ICT makes it easy and possible for learners to understand, to get clarity and abundant of information even out of the classroom”.*

It is important to acknowledge that it is one thing introducing a system, and quite another monitoring and mentoring beneficiaries of the system to make use of it to its optimal potential, in order to realise the value it brings in improving the individual and society.

Regarding the use of the “Blackboard” service, two participants expressed their lack of knowledge due to insufficient exposure and training. One student participants commented:

*“I don’t know anything about ‘Blackboard’ but I heard my fellow students from mathematics stream talking about it. I never had the opportunity to attend any of the workshops so when coming to ‘Blackboard’ service I am clueless (S2).*

The second remarked:

*“I have never had or attended a workshop which was addressing this initiative. But last year on my 3<sup>rd</sup> level, our mathematics lecturer introduced it to us. The reason we were introduced to this (‘Blackboard’) was to reduce the amount of contact with the lecturer in the classroom. We were receiving the materials and you can also send your concern if you have. But there are many features on the “Blackboard” which we do not know” (S3)*

Though the service was meant to assist the students with their studies it is not being used to its fullest extent. This view was established from two student participants’ responses, as follows:

*“‘Blackboard’ is one of the communication technologies I was exposed to, though few contact sessions were done. I couldn’t learn much about such communication technologies as I couldn’t receive proper instruction on how to use it to access module materials” (S5)*

S6 contended:

*“I had only two to three chances for two weeks last year in my third level of study to access ‘Blackboard’”.*

Despite the participants’ limited exposure to the service, some had positive comments to make, such as:

*“‘Blackboard’ simplifies the work of the lecturer or the educator even though it kind of deskills the educator or the lecturer. It makes the course work looks easy from student point of view which sometimes misleads the students. It makes the lecture interesting and as students we turn to concentrate during the lecture” (S1).*

Similarly, S4 asserted that:

*“‘Blackboard’ service provides an easy way to communicate and share information between the lectures and students. Lecturers are now able to send lecture notes, hand-outs or any study material online and students have access to this material anytime”.*

Also affirmed by S5:

*“‘Blackboard’ service is very important though I was not exposed to its content. As students we can interact with each other via ‘Blackboard’ without attending traditional classes. With ‘Blackboard’, you learn at your own pace but still obey lecture rules of the content. Using ‘Blackboard’ can expose students to the use of internet service. Students can access material via ‘Blackboard’”.*

From the preceding comments, the participants view the 'Blackboard' service as a complementary resource to the traditional teaching and learning process. However, one student participant claimed that lecturers' moderate use of ICT facilities such as Blackboard does not challenge students to use available technological resources, as stated:

*"I can say that, because that one of using, communicating with us via 'Blackboard's or the internet, it was only used by one lecturer" (S4).*

It is worth noting that productivity tools provided by the institution are not limited to the 'Blackboard' service only, but includes the potential use of Microsoft packages such as 'word', 'excel' and 'power point' in rendering assignments and offering presentations, Wi-Fi, and the internet.

Student participant five (S5) complained about teacher trainers' scanty use of technology in classroom teaching, with emphasis on the internet and 'Blackboard' as the main resources they use, as illustrated in the student's comment:

*"The first one is internet. So with internet they just give us relevant websites to check the information and to check another additional maybe tasks or activities that we have to do and the other one that we use it is 'Blackboard' of which we did not have that much experience on, but otherwise we were able to access material from the 'Blackboard' system and be able to do the problems".*

(S5) further lamented that the institution controls search engines available for use, as he expressed it: *"other search engines are blocked"*. Limited resources, institutional control of software and other tools for understanding restrict access to a variety of information and opinions from numerous search engines. Hence, inadequate infrastructure provided by the institution hinders the acquisition of knowledge on ICTs and poses a challenge for ICT skill development.

Discussions with the participants revealed that, despite the limited productivity tools at their disposal, they rationalise their use with some degree of confidence and competence. One student respondent professed:

**S3** *"...I think I will integrate it in the curriculum. So far with the experience from, in this University, I think I can integrate it".*

This student claimed to be very competent with the ICT resources interacted with, and foresaw the integration of technology in future classrooms. He appreciated the value of ICT and the contribution it could make to teaching and learning.

It is valuable having the ability to identify ICT tools and confidence in using them. However, the fact still remains that it is important to understand how and when to use these tools for effective studies.

#### **4.2.3.2 Students' approach to ICTs**

Many students enter tertiary education with high aspirations and hope for a better future and opportunities. These dreams and desires are greatly moulded by lecturers and others who are involved in shaping the future of these lives. Many come from backgrounds with limited ICT exposure, hoping to emerge well equipped and grounded in ICTs, well prepared for lifelong learning, and ready for the employment market.

Many of ITE students come from secondary schools with limited ICT infrastructure. This poor ICT background came to light in the responses received from the student participants, but did not impact negatively on their attitudes towards ICTs in learning. Some of the comments were:

*"I am a young man who grew up in deep rural area of Sekhukhune in a family of eight. I attended both my primary and secondary schooling there. After passing my grade 12, I went to the university to study BSc."* (S1)

Despite the poor ICT and weak basic academic background, the desperation and enthusiasm to work towards a better future, as a priority, was demonstrated in their response and resounded across the data. This is clearly reflected in the comment of three of the participants:

*"I'm ambitious goal-oriented young man who believes in the power of his dreams. Acquiring knowledge is at the core of my entire being. I'm internally motivated to achieve my goals in all the spheres of life. Though sometimes academic spheres seem to be challenging, I hold unto my career and belief and have faith in God and talents that He gave me. I love studying and am curious in nature and above all I'm pregnant with success. I understand that I have to endure labour pains before I give birth to success. Achieving academic goal is a process which requires perseverance".* (S5)

Another shared a similar sentiment:

*“I am the kind of person who strives to work to the best of his ability. I like science as much as I like mathematics but I struggle so much with science because I did not have adequate exposure to science at an early age as compared to mathematics. I strive not to look down on other people, disrespect them and keeping all that I have to myself i.e. I like sharing and engaging with optimistic people and helping those who are in need. My search for success in mathematics is that every problem has a solution, no matter how complex the problem may be, the solution is there and I will find it through perseverance” (S6).*

This goes hand-in-hand with **S3**'s comment:

*“I love maths mostly and I spent sometimes searching for jokes on the internet which are related to mathematics. One more thing is that I am passionate about mathematics and I want to make sure that my future learners come to see mathematics as the simplest subject through the use of ICTs”.*

These responses are indicative of students' positive approach to learning, and how determined they are to overcome any kind of challenge that will impede their progress and are willing to do whatever it takes to make learning interesting.

Students' approaches towards ICT usage emerged through their interaction with lecturers, collaborating with peers and self-determination. One student respondent (**S5**) argued:

*“When I look at how we have been equipped in our school, somewhere, somehow we don't have that much knowledge of ICT. So for myself, I normally go to the internet, search for relevant document on how best I can use ICT in my practice so in that way it helps me, because I cannot just say the school did not bring this issue to us. I have to go extra mile, search for relevant information on how ICT can help in my practice”.*

Though they have a positive attitude towards ICTs, it seems the necessary support received was inadequate to build up that knowledge base for effective use of the resources at their disposal, and beyond. One student participant suggested:

*“...one of the factors that disadvantage people to use ICT devices in the classroom is that they are looking at the negative side. They are too much attached to the negative side, but they don't actually look at the power that this device brings to us. So allowing learners and giving them the procedure, if we allow them or we train them to use these devices accordingly, they will benefit (S5).*

The students commented that the lecturers' refusal to use technology in the classroom could be due to their negative perception of students' use of ICTs, thinking that, allowing students to use devices such as smartphones in class would disadvantage effective learning.

#### **4.2.3.3 Understanding how and when to use ICTs**

Apart from being able to infuse ICTs into curriculum studies, one can only talk about effective integration of ICTs in curriculum studies if one understands how and when to use these devices. This is expressed in the comment:

**S1:** *"Browsing the internet to access extra supporting information in my studies. Watching video tapes related to what I am doing in my studies. Use tutorial software to practice what I am currently studying".*

Another commented:

*"ICTs can be seen as an important motivational tool and enhance productivity in our curriculum. ICTs can expand access to education, thus achieving authentic goals. It enables us to take learning away from school and into the world".* **S5**

It was apparent that the students' ability to understand how and when to use ICTs influenced their attitudes positively and motivated them to work towards conceptual understanding and improved learning strategies, which possibly transformed into quality learning and performance.

To determine the student participants' understanding of how and when to use ICTs this question was posed, touching on various ICT devices. "Discuss how you incorporate ICT equipment and hands-on materials (projectors, internet etc.), tutorial software, communication software (e-mail, chat, discussion forum etc.), digital resources (portals, dictionaries, and encyclopaedias), mobile devices (cell phones, iPods, etc.), learning management systems in their learning programme".

On the issue of equipment and hands-on materials, the participants expressed an understanding of how and when to make use of these facilities. Respondent 6 commented that during presentations, s/he uses a projector and the laptop, and sometimes uses the internet via the laptop to access information during lectures. Respondent 5 claimed that projectors can be used purposefully to display pictures

and images related to the topic under discussion. The view of respondent 1 was that the internet is used to access information to expand his knowledge. Furthermore, the projector can be used by lecturers and teachers to deliver teaching content, as expressed below:

**S5:** *“Projectors can be used purposefully for display images/pictures related to the topic under discussion. This can be done through teaching via multimedia”.*

**S6:** *“During presentation I used projector and the laptop and sometimes the lecturer request us to bring the laptops into the lecture session so that we can access information that will help us have a better sense of what we are learning about easily”.*

**S1:** *“Internet is used to access information that one can use to comprehend the information he has in the subject. The projector can be used by lecturers and teachers to deliver teaching or lecture”.*

Regarding the use of tutorial software, the participants seemed to have a very limited idea of the device. One participant (**S3**) suggested that the teacher could develop tutorials, or ensure that every learner had access to the tutorial software so that students could solve problems, irrespective of where they were situated. Another (**S5**) claimed that tutorial software could be incorporated into a learning programme through accessing tutorials using the software, as evident in the comments:

**S3:** *“The teacher can develop tutorials or make sure that every learner has access to the tutorial software so that students can solve problems irrespective of the place they are situated”.*

**S5:** *“Tutorial software can be incorporated in a learning programme through accessing tutorials via the software”.*

This is not evidence that the students are neither familiar with, nor have any understanding of what tutorial software is.

However, **S6** confirmed this.

**S6:** *“Unfortunately, I have no idea of tutorial software”.*

On the other hand, one participant seemed to be aware of the device and understood how and when it could be used, as reflected in the comment:

*“Tutorial software such as maple can be used by learners or students to draw graphs and work out calculations” (**S1**).*

Two of the respondents (**S2 & S4**) claimed that they did not use the software.

Seemingly, lecturers do not employ tutorial software for students to evaluate their progress. Two lecturers had this to say, when questioned about their use of tutorial software to assist student's build conceptual understanding.

*L3 "...in terms of tutorial software, I do not have any tutorial software. But I know there are many different kinds of tutorial software that you can actually be able to access, alright, but unfortunately my teaching and learning with my students, we don't use anything other than maybe the internet..."*

The lecturer demonstrated that he did not avail himself of any resources that could be used by students to evaluate their progress. Furthermore, he did not see the value of the ICT resource because he was busy with how to teach the content, as revealed in the comment:

*"The modules that I teach, they don't lend themselves to be using a tutorial software, because most of the time I am dealing with how I teach a particular content. So therefore it does not lend itself to that aspect. So therefore that is something I did not work on". (L3)*

The other respondents seemed equally ignorant about tutorial software and how it could contribute to students' achievements, especially their conceptual development and understanding.

Regarding communication software, the views expressed concerned using the device for social activities with little academic benefit. The software popular with the participants is email, which they use to submit assignments, communicate with peers and lecturers on academic and social issues, chat, or as a discussion forum to share ideas and information with one another. Due to their limited exposure to the 'Blackboard' service they could not link it as communication software. However, one respondent (**S4**) who knew and understood its use commented:

*"GroupWise was used for good communication between university lecturers and students via the net, then "Blackboard" was introduced which is more effective than "GroupWise" because now students can also engage themselves in group discussion".*

Though he cautioned against ICT dependency on information and claimed it could lead to a lack of reading skills, as he expressed:

*“The only challenge is if you depend too much on ICT, you are going to lack the skill of reading a book, because reading a book and going to ICT are two different things, because sometimes you will find that you are compelled to read a book, because the ICT or the internet is not there. Once you depend too much on the internet, you are going to have a problem, because you will always go to Google, even if a simple thing” (S4).*

This view demonstrated awareness by the students that knowledge acquisition that relied entirely on ICTs is not always complete.

However, most of the student participants appeared to be competent users of computers and the internet. They were quite comfortable with productivity suites, internet browsers and email programmes, and they used these applications widely to support their academic work. They claimed to use the internet to search for information, and to obtain notes and other resources from websites such as tutong.gov, science and mathematics websites, to further their understanding of topics being taught. S5 professed:

*“I normally go to the internet, search for relevant document on how best can I use ICT into my practice”.*

This is an indication of self-development towards ICT skills due to an understanding of the relevance of technology in the present digital space. Cell phones play a key role in this regard, according to the participants, in that they are a common handy device and are an easily accessible ICT tool at their disposal.

It is evident that students become more familiar with ICT equipment used by lecturers in their classroom, as expressed by one respondent:

*“Most of the lecturers use the projectors. When I was doing, when I was busy with my degree, the lecturer used to encourage us to use internet to get some additional information. So he used to encourage us. You have to go to internet. If you don't understand something you have to go to the internet and try to get some additional information” (S1)*

This shows that the most popular ICT tools amongst lecturers in curriculum delivery are the projector, computer and the internet, which limits students' exposure to other tools and marginalises their skill development. Another summarised it this way:

*“When I look at how we have been equipped in our school, somewhere somehow we don’t have that much knowledge of ICT” (S5).*

He went on to say:

*“When we don’t have resources at school, we become more of procedural. We give learner procedure other than the conceptual knowledge that they need. So ICT is to give them the conceptual understanding of which they will be able to draw out the procedural understanding” (S5)*

The student believed that the lecturer’s excuse of limited ICT resources is a cover-up to emphasise the procedural structure of presenting curriculum content, instead of using the available tools to assist students to construct knowledge using technology.

It is clear that the lecturers and students are aware of the contribution ICTs make in teaching and learning, and do integrate it into their programmes. However, the level of their knowledge base and pedagogical influence limits their use to information and communication resources.

Curriculum may be structured to incorporate ICTs in teaching and learning but lecturers do not seem to make use of digital technology.

#### **4.3 HOW DO MSTE STUDENTS’ AND LECTURERS’ BELIEF SYSTEMS (ONTOLOGY) AND PERCEPTIONS (EPISTEMOLOGY) REFLECT IN THE INTEGRATION OF ICTs IN TEACHING AND LEARNING?**

The previous section presented data on the integration of technology into teaching and learning by both students and teacher trainers. This section presents and analyses data on the ontological and epistemological orientation of the teacher trainers. This includes lecturers’ ontological and epistemological practices, lecturers’ embedding ICTs into teaching, lecturers’ aspirations and students’ receptiveness.

Epistemological and ontological assumptions were discussed in chapter 2 and are conceptualised and framed within the context of this research, as reflected in the lecturers’ use of ICTs.

### 4.3.1 Ontological and epistemological practices

Practices influenced by belief systems have a major effect on the integration of technology in teaching and learning. L1 contends that the 'Blackboard' service provided by the institution does not actually change her approach to teaching, but instead complements the traditional teaching. She admitted that the present generation of students are in a technology dominated environment (surrounded with technology) and are technologically literate. L3 supports this notion stating:

*"Our children have grown up in a technological world and they are used to these technology gadgets like the computers and others. So bringing technology to your lesson will automatically place them in an area where they feel comfortable. And because of that they would want to learn more".*

While L3 recognised the possibilities of technology in teaching, the comment is problematic because it appears to abdicate the responsibility of the lecturer to leverage technology in knowledge production. This view is similar to that of L4 below.

*"I am sort of a traditionalist. I am using the overhead projector, whereby I have got transparency and I just put them on the overhead projector and then project them to the screen. I think as the students have seen me doing it and sort of simplify the presentation, definitely they can use that, because my take on what influence students is what they have seen in class. It is what they have seen the lecturer doing, so if I use presentations probably they will do that ". (L4)*

This affirms the difficulty the lecturer had in adopting technology and adapting to it in teaching, being more comfortable in the traditional school and holding firm to that belief system. He did, however, appreciate the beauty of technology when used effectively by others, as expressed when he encountered a student during practice teaching supervision:

*"...I recall there was a time I went to see a student and he had a power presentation ready. He brought his own laptop and he had the screen. He was just doing it beautifully. So because there are other aspects or some other concept that can be better explained when you have them in". (L4)*

Though there is insufficient implementation of digital technology resources in the classroom, there is evidence of employing technology in curriculum preparation. Furthermore, there is a demonstration of ICT ontology acknowledging the benefits of ICTs, including the development of skills as the lecturer sees student teachers use technology in their practice (Packer & Goicoechea, 2000:1). This acknowledgement and appreciation of technology may alter the participants' epistemological assumptions on ICT that could lead to appropriately transformed teaching and learning to embrace the dictates of the digital environment.

Similarly, another lecturer demonstrated a firm belief in the traditional approach of curriculum delivery, and a resistant attitude towards the integration of digital technology in classroom practice:

*"The students that we are teaching these days, they are not old fashioned like we are. We are the BBDE kind of people and you know to an extent that sometimes it annoys me that when you ask them a question 20 multiply by 10, they would quickly rush for their calculators and with us, we would know. When you ask them about definition of something they will quickly go for..., to Google. You know with us you would know the facts. You would know these definitions and so on. So for me it supports. You know it does not necessarily take over" (L1).*

This shows that integration of ICT in teaching is not part of the lecturer's epistemology. She does not have ICT ontology and distances herself from ICT. The students are seen as the other (who are ICT oriented) because the lecturer declared herself as a BBDE and tried to draw other lecturers into that fold. Moreover, L1 demonstrated a 'carefree' approach towards students' conceptual understanding which is a great worry. This is evident in the comment:

*"Once I meet with them and I did for instance, suppose it is a new topic, I introduce the topic and explain, then from there refer them to the 'Blackboard'".*

Sending students to use ICT after introducing a new topic and a brief explanation may not help them to develop a conceptual understanding of the issue. However, using the technology with them, and guiding them on how efficiently and effectively it

could be used, would inculcate skills. It is always good to start with the basic resources, such as the Blackboard, and gradually develop oneself to a complete integration of technology in teaching.

Further, presuming that students mainly use ICTs (search engines) to play games and not subscribing herself to using technology in the classroom, she added:

*"...You may take it that they use the Google for playing games and stuff, but with others, it is more than seeking for information". (L1)*

The lecturer does not link games to pedagogy and does not associate games with teaching and learning. Seemingly, there is a need to transform one's pedagogy to allow for the integration process.

*"Okay, you know one thing that I noticed with the students and the way that ICT helps is that they can communicate, ask you know, seek for more information in case they did not understand by calling me and say oh just write an e- mail to say I did not understand this. Is it correct if I do it in this way and so on"? (L1)*

This demonstrates the lecturer's view on ICTs and students' engagement with the resource:

*"....and one thing that helps me is that when they come with problems I want them to show me how they did it before. Where did they go wrong? Where did they get stuck and we will take it from there, but if they come blank then I don't attend to them... I have been giving them problems to determine to give them questions and they will seek for answers. Ja, as I said it will only be the hardworking ones and the intelligent ones who will come with something new. What does it mean? Is it true? Has it been proven? And things like those". (L1)*

This response illuminates a generation gap, a major contribution to some older lecturers' negative attitude towards technology. Those lecturers, born before the rapid emergence of digital technology, are very comfortable with the traditional pedagogy and are resistant to any form of change that may require them to alter or indulge in pedagogical transformation which contributes to the acceptance of digital technology.

L3 commented, with a strong advocacy slant:

*“...as a teacher is that I also have to look at how things have changed and when I look at how things have changed, I have to ask myself how do I now embrace this change? And whether we like it or not, at the moment if you do not incorporate ICT into your teaching, then it means that you are not keeping up with what the current changes are taking place right now in the country. Not in the country, but globally”.*

Hence, it is important for lecturers to use technology to enhance what they do in the classroom and improve on teaching practice. Teacher trainers have to adopt and adapt technology in their curriculum delivery in order to keep up with the demands of the 21<sup>st</sup> century. This calls for pedagogical transformation and practice re-orientation.

Despite the fact that some lecturers do not use advanced technology they acknowledge its relevance in the new space of teaching and learning, starting with the Blackboard concept. Despite the fact that most lecturers do not use technology in curriculum delivery, the IT section continuously makes efforts to motivate staff through workshops, sometimes, using other lecturers as instructors, through induction programmes, encouraging and enumerating the benefits and advantages of using ICT. Also, lecturers' attitudes to the use of technology highlighted an absence of adequate physical resources, skills and knowledge as a significant hindrance to technology adoption.

#### **4.3.2 Lecturers' embedding ICTs into Teaching**

Lecturers' responses to the open-ended questions during the interview revealed that they perceived the integration of ICT as a necessary mission in their programmes, and acknowledged the valuable contribution it would make in the culture of teaching and learning, and for future success in an information society. One lecturer (L3) noted the reason for this necessity as:

*“As teachers, we must be able to say, using technology, is it possible for it to enhance what I do in the classroom? Today we will only use the chalkboard and all your life you are only going to use the chalkboard. Can you imagine while you are busy writing on the chalkboard, the student in your class busy accessing the internet with all the information in the palm of his hand whilst you are still busy writing on the chalkboard”.*

This participant recognised the need for a change in teaching design and approach in order to foster a move towards 21<sup>st</sup> century skills acquisition, and thus fit teaching into the students' technological learning environment. Further, the participant showed an epistemology that aligned with modern thinking that requires the necessary ICT ontology for the efficient embedding of technology in teaching programmes.

Another issue that was highlighted by all the lecturers was the relative advantages of integrating and embedding ICTs and using a variety of resources in curriculum delivery to enhance the performance in their instruction, improve the quality of instruction, be more efficient, and improve students' understanding. This is illustrated here:

*“Most of the time when I teach difficult concepts, I use cartoons to keep students engaged and they come asking, where do you get these cartoons from? But you see at the end of the day what is important is that you say to them that teaching is not only about the textbook or about what you can write on the board, but you can present it in a much more better way and I think that is what is critical. So that is how you translate it to your students, by also demonstrating yourself and trying to bring in different things into the classroom”.* (L3)

This evidence of ICT ontology and elements of modelling showed an aspirational and clear indication of epistemology, coupled with the trajectory pedagogical integration of ICT in curriculum delivery.

The participant further suggested that to entrench technology skills required support from the lecturers and the institution, as reflected in the comment:

*“When you go to visit them (student teachers) in the classroom, that is when you have that opportunity to be able to say okay alright this is what you have done, alright and I think this is how you could enhance this particular lesson or this is how you can improve on this lesson. This is the information that you can draw from and that can help you to present this lesson in a different way and in that way you also, what happens is that you encourage to them there is a different way for you to think about something”.*

L3 continued and emphasised:

*“Also many times they do presentations and we always try to give a comment or a feedback. And that sort of helps them and encourages them”. (L3)*

A reflection of the lecturer’s epistemological orientation emerges with the issue of providing guidance, support, encouragement and direction as prerequisites of instilling the skills transferred to the student teachers.

The lecturer respondents acknowledged the importance of the students’ desire to use ICTs and saw this as a challenge to improve their pedagogical integration of technology, as students require the necessary encouragement. One respondent (L3) acknowledged the students’ desire to use ICTs and the positive effect it would have on their conceptual understanding:

*“...in terms of ICT one of the things that we use, we allow students to either they can access ‘Blackboard’, they can access the e-mails. They can also be able to access the internet”.*

The lecturers admitted that, though ICT integration would require altering their pedagogy, it would be very supportive and effective and make them better professionals. One participant expressed:

*“When I teach mechanical technology, for instance if I talk about an engine which students have never seen before, what I normally do is after the video that I have presented in class, I will bring them to my office, then you go to the relevant sites that demonstrate the application of the engine and all those, which they find interesting, because they see it actually happening and they can see the process. In that way the ICT compliments what I did in class, ja, and they emphasise that, even students on their own, they can go and explore this further in laboratory or their own personal computers” (L4).*

This illustration provides a strategy demonstrating lecturers’ use of ICTs in teaching, evidence of transformed pedagogy and epistemological assumption of making good use of technology to advance students’ conceptual understanding of subject matter.

Though some of the respondents seemed to be transforming their teaching pedagogy to fit into the technology era, few still appear to be working in a particular cultural context (the traditional domain of course delivery) that militates against the integration of ICT into their teaching and learning programmes. However, all the lecturer participants expressed concern that the integration of ICT should not only be at course delivery or subject-matter level, but should also be an institutional development. Lecturers should be knowledgeable about the use of ICT tools, especially the technical aspects of them to allow them use the tools more efficiently

### 4.3.3 Lecturers' aspirations

The social responsibilities of the lecturers in the department contribute either positively or negatively towards their pedagogical integration of ICTs in the performance of such duties. With the exception of respondent 1, all the other respondents indicated their involvement with student supervision at practice teaching level, engaged with postgraduate students, designed and implemented teaching materials and were eager to produce ICT knowledgeable students who could make a difference at their places of work. One respondent contended:

*"I wish to produce graduates that are well-equipped and confident in teaching Physics and contribute positively to the community they will be serving, technology literate so that they can fit well in the 21<sup>st</sup> century, knowledgeable, have skills, diligent and be able to transfer what they have learned". (L3).*

With such aspirations and determination, coupled with strategic thinking consisting of innovative, critical reflective systems and forward thinking, the fundamental components of excellence in curriculum delivery could be established through effective and efficient integration of ICTs. Lecturers, by virtue of their social standing, are there to provide direction through a proactive transformational mind set for quality teaching and learning, with the emphasis on ICT skill development. As one lecturer participant said:

*"I intend to create a formidable technology education hub with sufficient pool of post graduate students. Our students, particularly undergraduates should develop authentic solutions" (L4).*

The same participant, however, expressed dissatisfaction with the injustice being done to teacher training in that the student teachers are not well equipped with

technological know-how, and that the curriculum is compromised. Consequently, critical thinking skills were not encouraged by some academics due to their epistemological and ontological assumptions.

#### **4.3.4 Students' receptiveness to ICTs**

The social standing of students challenges their epistemological and ontological orientation in many ways, and contributes to their receptiveness to ICTs in curriculum studies. When given the opportunity to decide where to do their practice teaching (fieldwork) many choose areas where the challenge of using ICTs is basically limited, or non-existent. One student participant, well equipped with ICT skills, and demonstrating a high level of confidence, chose schools which are well equipped with ICT resources. Furthermore, the opportunity was created to allow him to use these facilities in teaching mathematics and physical sciences to different grades; as the participant commented:

*"I did practical teaching in various schools during my study of the programme. I was teaching both mathematics and physical science in various grades such as 2009 (grade 11 &12); 2010 (grade 10 & 11); 2011 (grade 9, 10 & 11) and 2012 (grade 9, 10 & 11) In most of my subject content delivery, I used computer and simulations to explain concepts" ..(S4)*

And again:

*"I enjoyed my time in this programme and I have learned a lot of things. Mostly I enjoyed mathematics and surely my future learners will learn a lot of things from me and they will find me the best teacher. I was taught to be independent and use technology and not to rely on the teacher/lecturer, and now this is my objective when I teach my learners to ensure that all my learners are independent" (S4).*

Despite social challenges (socio-cultural and socio-economic) most of the student participants claimed to have transformed their weaknesses into strengths. This is portrayed in the following comments:

*"The programme was challenging and equipped me with various skills and knowledge in the field of mathematics and physical science education. Some of the skills that I have acquired during the study are skills such as interpersonal skills, communication skills, computer skills and a change of attitude towards mathematics and physical science". (S4)*

Similarly, **S5** claimed:

*“The programme offered me an opportunity to understand all the major aspects of what teaching is all about – it’s more than writing on a chalkboard. These programme also provided me with a psychological aspects of both teachers and learners. Understanding how learners are and behave is imperative in about bringing good and effective teaching and learning. I have accumulated important aspects of pedagogical content knowledge which is at the core of any teaching programme as well as how ICTs could be used to improve content delivery”.*

Student participants’ interactions with technology in the learning process paid dividends, in that it boosted their professional development, which shows the impact of technology on teaching and learning. They saw the benefit of ICTs and how it can transform curriculum delivery, thus making teaching and learning fun, interesting and more comprehensive.

The above presentation shows how lecturers and students perceive ICT integration in teaching and learning, and how they view knowledge construction and production, using technology.

#### **4.4 IN WHAT WAYS ARE ICTS USED TO SUPPORT STUDENTS’ INNOVATION AND CREATIVITY IN MSTE?**

This section presents and analyses data on the use of ICT by both students and lecturers in the teaching and learning of mathematics, science and technology. The issues presented include: innovative and creative use of ICTs in the teaching and learning of MST; creative learning, using ICTS; social networks as a creative and innovative resource for learning and ‘Blackboard for creative learning and innovative teaching.

##### **4.4.1 Innovative and creative use of ICTs in teaching and learning**

Creativity does not feature prominently, or play a central role in the curriculum. However, lecturers’ innovative pedagogies would see students apply creativity to every domain of knowledge and to every subject specific area. Creativity as a transversal skill is vital to teacher trainers and could be enabled by ICTs. With a sound vision of ICT and learning, whereby learning is an interactive, social, innovative and learner-oriented process, creative learning practices could be enabled through effective integration of ICTs in teaching practices.

It must be mentioned that effective integration of ICT in teaching and learning should go beyond simply replacing, streamlining or accelerating current practices. It is necessary to find new and more effective ways of operating and supporting pedagogical trends that enhance innovation and creativity at all levels of education and training. It is crucial that our students develop their sense of creativity and their capacities to innovate. The role of ICT in learning and teaching, in particular to enhance cross-cutting skills, such as creativity and innovation among students, was highlighted in the interviews with the participants.

Though intelligence is not a necessary prerequisite for creativity, knowledge is of substantial importance as it triggers creativity and shapes creative outputs, as well as expertise, which are unquestionable attributes of the creative mind. The use of ICTs to support students' creativity and innovation stems from lecturers' innovative teaching, which includes the process of teaching for creativity and the application of innovation in teaching.

It must be understood that creativity is not only desirable, but also necessary, because it involves co-construction of meaning, and promotes an active role of the student and at the same time requires new methods, formats and approaches, thus requiring an innovative role by the lecturer. This is illustrated in L2's comment:

*“Actually when I give my presentation I make sure that it is colourful to get some of the designs that are there in the computer just to help my presentation attractive to them and this animation stuff, this thing of hyper linking stuff, you will find that you have an idea, but there are some ideas around it. You would present an idea and then press one by one to express the ideas that are around that big idea. So in that case it becomes so interesting and it enhances and encourages people to feel like doing this thing”.*

The fostering of creative learning and innovative teaching does not uniquely rely on the intention of lecturers and students, but also on tools and common practices that provide the circumstances for creative learning and innovative teaching.

Using ICT enablers, such as laptops or desktop computers via the internet, to simulate or animate difficult concepts, is an innovative teaching method, while at the same time generating creativity and student involvement:

*“...You know lecturing only won't be effective and it won't make teaching interesting. I think it is important to use other things like bringing their laptops in and going through them and something that they like, you know, they are advanced, far advanced than I am when it comes to such devices. So it simplifies things for them, because it is something that they like. That is number one. Number two, it also motivates them to seek for more information to say okay this equipment can also be used for such things, you know, and not for playing games and playing music only and with that at the back of their minds they can also look for more information from other courses, modules and so on. And I think it also motivates them and I am sure when they are going for teaching practise or teaching, for those for are completing this year, they will use the internet” . (L1)*

As expressed by the participants, the role of the teacher in the educational environment is fundamental to bringing about a new pedagogy or to stimulating change and making learning interesting. The promotion of creativity and innovation needs to be articulate and coherent, and needs to be constantly mirrored by practice.

#### **4.4.2 Creative learning using ICTs**

Any learning which requires understanding, invention, making new connections, or seeing things in a different perspective over memorisation and rote learning of facts could be referred to as creative learning, and ICTs seem to encourage that. The respondents appeared to encourage student teachers to use ICTs generatively.

*L1: “- I paste interesting, life related questions on “Blackboard” for the students to respond. The other time, I requested them to bring their laptops to class and browsed through so to see the animation of nuclear reactions. They went to search for more and were able to understand how nuclear reactions take place”.*

L2 admitted that there is no creativity, due to a lack of facilities, as in the comment:

*“Due to lack of such facilities in our teaching venues it is difficult to say that students engagement in such enhancing their innovation and creativity except showing the few slides that I prepare for my class. In short, it is not possible at this stage”.*

One is forced to question if facilities produce innovative teaching or the capability to do so through the available resources. The comments from the lecturers

demonstrate their narrow understanding of creativity and innovation as merely designing fancy presentation materials. This is reflected in the comment:

*“...innovation and creativity is essential for any beginning teacher. ICT enables information to be presented in creative and innovative ways. This enables students to view this and try to present their information creatively and innovation”. (L3)*

Another respondent (L2):

*“... I motivate my students through my use of technology. And the one other thing, you don't have to put a boring presentation. This are the stuff that I am talking to my students about, that your presentation should not be boring. At some stage has some fun pictures, that as they see the slide, let that thing catch their attention that they will listen attentively to you...”*

However, L3 embarked on activities that showed elements of innovation and creativity. The comment below revealed:

*“.....this ensures that the lesson is virtual and interesting for learners. Sometimes videos are taken of presentations done by students and this is viewed later for discussion by all students – allowing students to learn from practice”.*

Virtual presentation of lessons and reviewing later is a good initiation for innovative teaching that could inspire creative learning capabilities.

This view was reiterated by one student participant as below:

**S6:** *By using the laptop and the projector to project the lesson and sometimes instead of teaching I use video lesson in which learners watch the video. As they watch the video, I pause it at times to allow questions which may be from an individual and some of the questions may be answered by playing back the video.*

Integrating ICTs into teaching motivates interest in learning and inspires students to be constructive and participative in the learning process.

**S5:** *“The level of motivation is actually aroused when we see the things we are learning about. ICT can be used as it provides all the various pictorial and video clips which make learning more fun. Discussions become more motivated-centred as we “see” visual presentations which provide insight and direction on our learning. ICT incorporation in learning environment caters all various learning styles in the classroom when all learners are accommodated learning becomes interesting and individual learning experiences are developed”.*

L2 claimed to motivate and encourage students to use ICT creatively, but expressed concern about the lack of resources for students' use:

*".... I do tell them, but the problem is that, most of the time when I am with them; I am the only one having my own laptop due to unequipped lecture theatres. Also, because of the congestion that is there in our bigger program, they don't even get enough time to come and sit down with me to get more skills in ICTs, because they are occupied with this other modules. So they do just what the requirements are for your class for them to present something".*

An indication that the students are overloaded with academic activities and have little time at their disposal for engaging in any creative skill development is expressed in the comment:

*"...yes, as I indicated earlier, the program that they are involved in it is overloaded, such that even when they come to our classes they would look so tired. For them all they need is that information which will assist them to be able to pass the examination ..." (L2).*

For lecturers to get students involved in more creative and innovative activities calls for a reduction in the number of modules, which would create more time as L2 put forward:

*".... the Department (DMSTE) should cut down on the number of modules that the students offer and let them be focussed on their specialisations. Secondly, let's incorporate ICT in all our teaching and planning and create environments in our teaching classes, which will encourage such things, because now-a-days with ICT's some students has also created some experience through the computer".*

The participant did not explicitly articulate how this would lead to innovation and creativity, but there is evidence of a belief in integrating ICT in curriculums and the relevance of ICTs. With or without a reduction in the number of modules, the type of task given should encourage creativity, and the approach to teaching must show evidence of innovativeness.

The students, on the other hand, acknowledged the important role ICTs could play in contributing to developing creative ways of learning to maximise conceptual understanding, as expressed by one of the respondents:

*"... I collect as much as possible information and compare and look at one which is much simpler than the other and I go for that one..." (S1).*

He/she went on to comment:

*“..if there is something I don’t understand concerning what I am doing in class then I will have to use my cell phone to consult my fellow classmates and go through the internet and make research and try to get some related information concerning those topics” (S1).*

Thus, the innovative and creative use of ICTs to enhance learning and develop the understanding of concepts beyond the classroom environment was affirmed by a second student participant:

*“When you learn something from the class, you will find that there is that limited knowledge, but you are given maybe a website and then when you go to get that notes, then they relate to what happened in class. Then you develop your understanding of that”. (S2)*

Another respondent (S3) contended:

*“Usually, you will find that maybe in the class we are all struggling. You just quickly go into the net and I find something. Once I bring that, even though it is not that clear, but once I bring that into the class, then at least some of the fellows will get at least the understanding or they will get a way at least to explain that concept”.*

In this way the strategic use of ICT to support learning and understanding, is promoted.

The few students who are familiar with ICTs make use of resources, such as the internet, to obtain more information on the topics discussed in class, in order to improve their understanding and to advance their learning objectives. Three of the student participants affirmed their use of ICTs to enhance their conceptual development and understanding of science and mathematics issues. Respondent two (S2) claimed:

*“Maybe I come across something that attracts my mind and then I don’t have any clue. Then I go to the internet and search that thing so that I can be more familiar with that particular thing. So I usually use it to browse besides communicating”.*

A second student commented:

*“...Ja, in most cases I can go into the net and then we search the information and then we summarise the information, and we put them in the power point and then after putting them in the power point, then we present them for learners as a summary” (S3).*

This indicated creative learning with digital technology and the use of animation to configure complex concepts, especially those in chemistry. However, the student did not use digital resources such as dictionaries and encyclopaedias to enhance conceptualisation. Participant four (S4) professed:

*“... Oh what I do, let's say for example I am doing something that is very difficult. I don't understand. I will write that thing down and when I get to my room, I will open my laptop and I will Google that thing. So the internet will give a lot of responses and everybody will be explaining the concept in his own way”.*

The student does not display an understanding of what it means to be creative and innovative, using technology, but does understand that it could make one less reliant on lecturers, classmates or peers.

Respondent (S5) was pleased with how the innovative use of technology transforms learning, and declared:

*“When we look at science specifically, it is more of a practical subject. So using ICT devices, we can be able to see oh this information is more relevant to what I have encountered in real life situations other than in practical, in a class room situation”. (S5)*

It seems therefore that creative and innovative use of ICTs helps to make meaning, and enhance appropriate learning in a variety of contexts to stimulate understanding. However one participant cautioned:

*“...but sometimes it spoils us, because let's say if you don't understand something, you don't try to get it. You will just go to Google and say what and try to search for information. Ja that is how I use this internet”. (S1)*

Though S1 acknowledged the value of ICTs, he at the same time expressed concern about the effect of over-reliance on the internet.

Further interacting with the student respondents revealed their inadequate use of ICTs for creativity and innovativeness. The use of social computing applications to develop skills, such as blogging, sharing of multimedia (e.g. You Tube, which is not available on the institution's network), online gaming, and the sharing of bookmarks (Citeulike), to mention but a few, are not readily available to them. They expressed familiarity with social networks such as Facebook, WhatsApp, Mixit and others, which they mostly use for social chats, or with some academic discussion with either

their peers or lecturers, but not with social computing applications. It must be emphasised that social network media vary from social computing applications. These applications demonstrate a variety of means of learning and offer new opportunities for students to express their creativity, and make it available to a large audience and to get feedback and recognition (Cachia et al., 2007). They constitute a major component of creativity and innovation about which the students lack awareness and knowledge.

The students mentioned the conservative manner in which lecturers use technology to advance their teaching and engage them with ICTs, thus hindering their potential creativity. The students believed that they could be empowered to be more responsible for their own learning, using ICTs, if there was a change in the cultural mindset and a shift of pedagogy among the lecturers and other stakeholders in the institution, who in one way or another contribute towards their learning agenda. One student respondent expressed the concern that using presentation tools in class does not necessarily stimulate creativity and innovation: lecturers' use of such tools only enhances their presentation skills. This emerged from the comment:

*"It is all just about presenting. It has nothing to do with being creative, but the other things that you can write, most of the things that you are going to talk about on your presentation, you don't have to think about most of them and some, you fellow classmate is just going to read them on your presentation". (S1)*

The student claimed that the nature and manner in which lecturers use ICTs is predominantly about presentation skills and has nothing to do with creativity and innovation.

#### **4.4.3 Social networks as a creative and innovative resource for learning**

Acknowledging the important role of social networks and a new approach to learning could contribute to conceptual understanding through academic discussions, obtaining instant feedback and being cost effective. However, most of the lecturers seemed to distance themselves from this medium. Participant L1 commented:

*"... I heard one of the students saying this is how she discusses with other group members, students from her group. That is what she told me, but then I don't use that. I only use the e-mail..."*

L2 declared he had never thought of using social media for students' academic progress.

Seemingly, few of the lecturer participants consider social media as a necessary resource for originality in developing conceptual understanding (for a variety of reasons), though they admitted that it could play a valuable role in that regard. This came out clearly from the comment made by respondent (L3):

*"I understand that there is a place for that, but I think that sometimes maybe we need to think about it carefully, but if you have it on 'Blackboard' and you have a forum that is there, it can help, because it gives them that space to talk. You know. But social media it is something that is relatively new, especially to use in terms of the classroom or even a simple thing like a cell phone, because the most of the students do their assignment on social media and on cell phones".*

The students, on the other hand, consider the use of social media a resource for teaching and learning, as revealed in this comment: *"...sometimes we discuss issues and then we also try to solve problems using chatting devices or media" (S5)*; S5 further commented: *"We discuss issues and then we also try to solve particular problems using chatting devices"*, showing the importance of collaborating with peers using technology such as chat rooms, to secure conceptualisation.

Listening to the students discussing this medium as a valuable aid to conceptualisation revealed how they could incorporate social media in their learning programmes, expressed as follows by one student:

*(S4) "...we do that one, in method class mostly ja, we do that one. We find that we are learning something or you just want to solve a problem, but we did during our high school days, so you will just take your phone, maybe get a classmate on social network for help".*

However, they use the medium mainly for social issues, as outlined by the participants:

*"Most of as us students actually have opportunity to use the WhatsApp and the Facebook, but we don't usually use it for academic relating" (S1).*

This student engages social networks for social activities which have nothing to do with academic adventures. This could be due to a lack of exposure to ways of using these tools to advance knowledge acquisition. Participant (S6) claimed: *"We just communicate with meeting and then discussing the problem personally. They have like twitter,*

Facebook, and also, I don't access those". This individual subsequently expressed reservations about the potentially distracting effect of such media:

*"Actually one thing that I am afraid in those things is to be like absorbed in them too much, because most of your time will be dedicated to chatting, be always on your cell phone. So that is one thing that I don't like. Like also to..., because most of time, in my experience, or from my knowledge I think for chatting it makes you at the end not being secretive. You don't have secrets and even someone tells you just expose it on there".*

This is an indication of fear of social technology through a fear of addiction, looking only at the negative impact and not considering the positive.

Participant (S3) cautioned:

*"...with social network skills, sometimes you become addicted, you become more and more addicted. You will find that you are no more concentrating much on your educational issues. You are focussing on social network, chatting and so on. Sometimes you spend a lot of time searching unnecessary information instead of doing something academically*

This student admitted the impact of the social network on learning, in that getting addicted could pose a danger to one's academic development, since they are, in most cases, not used for creative learning undertakings.

Most of the lecturers seemed not to subscribe to the use of social media to advance academic programmes, holding the view that engaging students on the social network is an intrusion in their space. They distinguished between social and pedagogical spaces, and advocated staying away from the former. L3 said:

*"I think that it is not an easy place to go, because on the media, the social media platform, the only thing that you are talking about is social issues. You know and in terms of learning, not many of us can embrace that aspect and I think that it is a space and sometimes I don't know, students find that this space is their space. They have time for own space. You know sometimes you know we cannot become and want to put academic things. I understand that there is a place for that, but I think that sometimes maybe we need to think about it carefully..."*

However, with access to smartphones, it could be a platform to explore with a view to enabling students to consult any time they are in academic difficulty, since they already use it to discuss either academic tasks or social issues.

#### 4.4.4 LMS - 'Blackboard' for creative learning and innovative teaching

The institution provided the 'Blackboard' system to improve curriculum delivery creatively, through innovative teaching; but the students claim that they are not equipped to benefit from the full educational potential of the technology. As one student participant commented:

*"Actually I don't have a clue of what "Blackboard" is, I have never used it, and I do not know anything about it, although I am very much aware of it because I heard my colleagues talking about it. The ones who are in the other streams they have been trained for that. So I heard them talked about it, but I have never used it and I have never seen them used it" (S2).*

Another respondent remarked:

*"Yes the 'Blackboard' is good; the problem is like not all of the students are covered. It is only a certain group that was somehow equipped with "Blackboard" and some groups were not bothered about. We just heard it before that there was going to be "Blackboard" and after that it came we never heard anything about it anymore. Sometimes, when you go to the computer laboratory and it is closed or you find students logged on the computers busy with it, but they never logged onto 'Blackboard". (S6).*

Despite the positive side of technology-driven instructional strategies, there is the fear that technology-based tasks may result in reduced interaction and direct contact with lecturers, and could alter the 'norms' of the lecture rooms, where students with good technical skills become expert advisors to the lecturers and peers. This might either encourage or discourage colleagues and the learning process.

Student participant (S3) commented:

*"...with 'Blackboard' it was very helpful, because sometimes she used to say okay you must not attend a class. At least I will just stay in my room. I have my laptop and I will stay in my room and then I access the information while in the room without going outside. The disadvantage will be those who do not have a laptop. Then they will have to go to..., but still it is good".*

The participant acknowledged the role of 'Blackboard' as a relaxed learning medium, but could not explain its use creatively and innovatively for constructive learning. He again sounded the double caution regarding inadequate resources to manage

learning, and the possibility of less physical contact with lecturers and peers: “if there is a problem, sometimes we have our groups. Then we can arrange and then we go and discuss the exercises”. (S3)

Participant (S6) expressed dissatisfaction about the institution’s inability to instruct all the students on the use of the facility:

*“...It is only a certain group that is well equipped with ‘Blackboard’ and some groups they are not even bothering at all. We just heard it before that there is going to be like ‘Blackboard’ and after that it came, then we never heard anything from it anymore. Sometimes when you go to the computer lab the lab is closed and you find students logged on the computers and they are busy with it, but he never logged onto his ‘Blackboard’”.*

This is an indication of poor communication and failure to make use of the resources available, to the university community.

For ICTs to be used innovatively in teaching to generate creative learning approaches, lecturers and students must have a clear understanding of the potential of the resources and be able to link that to teaching and learning. There has been a poor demonstration of innovative teaching by the lecturers, who do not seem to be assigning tasks that will inspire students to be creative in their learning.

#### **4.5 HOW ARE ICTs USED TO SUPPORT STUDENTS’ CONCEPTUAL UNDERSTANDING OF MATHEMATICS, SCIENCE AND TECHNO-LOGY EDUCATION?**

In this Section are the data and analysis pertaining to how ICTs are used by both lecturers and students for conceptual understanding in mathematics, science and technology subject learning and teaching. The areas covered include: ICT use and conceptual understanding of MST; lecturers’ ICT adeptness and students’ ICT skills development for conceptual understanding.

### 4.5.1 ICT use and conceptual understanding of MST

ICT capability is about having the technical and cognitive proficiency to access appropriately, use, develop, create and communicate information, and to develop knowledge and skills that enable the use of technology efficiently and effectively (Rastogi & Malhotra, 2013; cf. chapter 2). Lecturers and students should demonstrate this capability by purposefully applying technology to analyse and exchange information, develop ideas and engage these tools in adding value to teaching and learning. ICT becomes a powerful tool when used in simulation, animation or for modelling concepts that are difficult to understand and conceptualise. Experiments in science can be designed and virtually modelled, in a way that enables parameters to be quickly changed and the effects seen immediately. As one lecturer commented:

*L3: "The use of examples from real-life makes learning relevant and interesting for students. ICT enables me to find relevant practical, real-life examples to use in my classes. Learning should be fun, exciting and meaningful to students. ICT enable me to have these kinds of lessons".*

Using real-life illustrations adds value to teaching and contributes towards learners making meaning of what is being taught.

Also of crucial importance is ICT autonomy, through which students take control of their learning, engage with technology and work independently, or with others. Lecturers and students make decisions about what application or hardware best suits a particular task, and express reasons for their choice, as illustrated below:

*S3: "ICT resources can be utilised in incorporating real-world setting and application of learning. There is software which can convert world features into a mathematical representation. This can depict to learners that mathematics does not only exist in the classroom but it is also applied outside the classroom".*

The ability to identify and manipulate images and concepts leads to understanding and an appreciation of the valuable role of ICT in conceptualising and constructing knowledge.

Further, creativity and innovation inspired by the use of ICTs should render students ready to explore opportunities and venture into the unknown. Lastly, for quality teaching and learning, there must be a demonstration of ICTs being used to develop sophisticated thinking and analysis among students. They should use technological resources to share knowledge and ideas to enhance their understanding. This is evident in the comment:

**S4:** *“GroupWise was used for good communication between university lecturers and students via the net, then ‘Blackboard’ was introduced which is more effective than ‘GroupWise’ because now students can also engage themselves in group discussion”.*

Seemingly, students and lecturers use ICT to enrich teaching and learning, making use of the wide range of sources and material available to them.

The analysis below shows how the factors mentioned above are reflected in the use of ICT for conceptual understanding.

#### **4.5.2 Lecturers’ ICT adeptness**

The response obtained from the lecturer participants indicated that all of them perceived themselves to be proficient in basic ICT knowledge, within the framework of using Microsoft programmes, the internet, and presentation software, for personal and instructional purposes. Yet they described their lack of competency when it comes to technical knowledge, such as the use of ICT in the analysis of a course, surfing for e-books and journals, Web-based projects and using a variety of search engines to obtain information.

The comments below show the adeptness of some lecturers using ICT:

**L3:** *“I search the internet for relevant resources to use in my classes; the internet enables me to find relevant articles to use in my classes. Websites like ‘You Tube’ enables me to access videos that I can use in my lessons. ICT enables me to access a wide range of e-books which can be used by my students”.*

Similarly, L1 commented:

*“I use it to access the internet, to research materials online, to research simpler ways to introduce a topic and uses in real-life situation (application in real-life) and to search for sub-topics that will contribute towards making teaching interesting”.*

There are others who perceive themselves to be competent in both basic and advanced ICT knowledge, to the extent of being able to access journal articles as well.

Using the internet to access journals, journal articles and electronic books is an advanced ICT skill that requires some level of competency to accomplish. Few of the lecturer participants possess this skill and use it to develop themselves. One lecturer went beyond self-development to equip the students with the skills to do likewise. This is substantiated by the comment:

*"... accessing journals, articles from journals, I just give them (students) the journal name and they go and access it on their own". (L2)*

This is evidence of linking ICT to teaching and learning. It is also a demonstration of ICT adeptness, integrating ICT into curriculum delivery with confidence. Sending students to access journals for knowledge building, and to websites to search for more information on what was discussed in class (as expressed by L2): *"I identify some websites for the students to visit and search for more information based on what we discussed in class..."* serves two purposes: getting students involved in their own learning, and developing a conceptual understanding of what has been taught in terms of skill development.

However, the students questioned lecturers' competency when it comes to the use of ICT facilities to assist them to develop knowledge and skills related to certain resources. One student participant alleged:

*"Sometimes it is a challenge to understand the software and nobody readily available to help. If you do not know how to learn to write matrix on the program, there is no way that you can add matrix. If you don't know how the graph using the same program, there is no way that you can do the graph. So first of all you have to understand that software". (S1)*

What the student seemed to be saying was that, while tools such as software may be available and ready for use, lecturers do not use them. It is therefore up to the individual student to know how to make use of such tools. This comment reveals that either lecturers are not well equipped with the appropriate ICT tools, or are incompetent to use them.

Furthermore, students expect lecturers to make adequate use of ICTs to enhance their learning and understanding, and help foster their eventual independence, as asserted by one participant:

*“Okay what I can do is that I will give learners opportunity. It is like if I check out the topic I will just explain it just a bit and then I left the rest to my learners, so that learners can go into the net. They can go and interact with different resources, then to get more information”. (S3)*

Living in the era of technology, but refusing to use technology in teaching and learning seems to point to lecturers’ technological incompetence. This was made clear in the following comment:

*“I have got slides already, but not on power point, because normally I use the overhead projector while I teach this subject, because it is sort of makes my job easier. I have never used any power point presentation, the reason being the limited resources in our school. If they were there then I could use it. Last year the experience I had with my third year students, I instructed them to do an assignment for instance about any technology. They just come and present as to how does it work and to my surprise when they came in with laptops, presenting with those laptops. It was beautiful. So in a way even though we don’t literally encourage our students to use ICT, they use it”. (L4)*

The lecturer participants believe that technology enhances learning, because students are allowed to operate in their zone, and with tools that inspire them. But to make good use of technology and surpass students’ knowledge of technology requires teacher trainers to upgrade their competency in using digital technology resources, and their technical knowledge generally.

#### **4.5.3 Lecturers’ ICT use as enablers for conceptual understanding**

Teaching for conceptual understanding relates to ensuring that students acquire the correct theoretical foundation through ICT. It is necessary to establish the knowledge that the student requires, as well as the knowledge the lecturer should project. Content knowledge and theoretical understanding are equally essential ingredients, as one participant reiterated:

*“If I use ICT the content knowledge that I would gain from ICT, alright that content knowledge that I would get from ICT it improves my theoretical understanding. Alright and the content knowledge that you will get is not only for one particular source, but you can get it from many*

*different sources and each of the sources will confirm the kind of information that you require”.*

(L3)

This comment reflects the importance of using a variety of sources to develop conceptual understanding. The most important issue here is how the lecturer uses these enablers in curriculum delivery, and encourages the students to use them as well, in order to build their understanding of the theory.

Giving students tasks that pertain to current issues drives them to seek the information required; in this way they learn and improve their content and theoretical knowledge. This is reflected in L4’s illustration:

*“... okay, when I mentioned the aspect about hydraulic fracturing or ‘fracking’ and I only used that as an example and gave it to a group to prepare a presentation. What I found was surprising, was when they did the presentation, the kind of information that they were able to bring across.*

Encouraging students to acquire ICT skills independently, so as to research and develop theoretical and content knowledge for themselves seems to be effective, though there could be some danger of their proceeding without the necessary coaching:

*“..... they went and researched for themselves. So that particular student that started off knowing absolutely nothing fracking can you imagine by the time they did the presentation without me having to teach it to them. They were able to come up and if you go and pose a question to them now about fracking, I am sure they will be able to enlighten you based on what they have learned, because of the readings that they have done. So I think that is how we try and make sure that students learn and they improve their content and theoretical knowledge”. (L4)*

This is evidence of a lecturer living the reality of the integration of technology, demonstrating an understanding of how technology can help transform learning and providing quality curriculum delivery.

It appears that most lecturers assign tasks to compel students to become familiar with such ICT tools as they might encounter in their career paths, thus to some extent equipping them with knowhow regarding such resources. One student participant (S1) claimed:

*“So rather we have to do some research and gather some information, relevant information, and then you write that presentation and you are going to use the projector. We also use internet to gather some information. Then some of the information you prepare a presentation and then you present that project to your class and the lecturer illustrate the projector”. (S5)*

Requiring students to use ICTs in the performance of assigned tasks helps develop their creativity, their conceptual development and their interpretation of issues contextually.

L3 commented:

*“...my post graduate students, one of the things that we always do, is if I get into the office I try to explain to them the data bases. I try to explain to them information that is out there, that they are able to access. How they are able to access information and so on”.*

Thus, students should be supported in the use of ICT in digging for information and identifying appropriate websites and search engines that can contribute to conceptualisation and skill development. This should be extended to ITE students, since they arguably need it most for the prospective teaching environment. The participant further claimed:

*“I spend some time trying to make sure that they are familiar with these things, so they must not come and tell me there are no ratings or there is no information out there. So that is why you take them through the process of identifying the data basis, identifying different sources of information that they are able to access and that is very useful, especially for them at the post graduate level”.(L3)*

Regarding inculcating the habit of using ICT for a lifetime of learning, a few of the lecturers access websites and suggest that students do the same, in this way helping them keep abreast of the changes taking place around them, and engaging with new developments. L3 stressed:

*“I always say to them okay, but you can also give me something new, either read in the newspaper or on the internet. So it means that already they are searching for new information, relevant information. What is important is that they have got to keep science current”. (L3)*

Thus is brought together ontology, epistemology, pedagogy and the appropriate use of technology as enablers to develop students' content knowledge, and theoretical

knowledge, as well as conceptual understanding, thus serving, to some extent, to position them in the 21<sup>st</sup> century digital space domain.

#### **4.5.4 Students' ICT skills development for conceptual understanding**

This theme concerns the areas that the students insisted, in the interviews, that they had developed themselves, with little or no assistance from a secondary service provider.

##### **4.5.4.1 Resource Tools**

The ability to use ICT resource tools is a skill that is taught, or acquired, through regular practice and interaction with such tools, so as to obtain maximum benefit from them. The students claimed to be skilled in using the ICT resources they had been exposed to, even though their knowledge base was limited. They conceded that there was more to be learnt if they were to fit in perfectly with 21<sup>st</sup> century ICT usage.

One participant (S2) pointed out two areas of competency:

*"...the one of the computer and the one of the data projector, ja that one I can say I am good at actually". Further claim that "...Yes, I can't say that I am that much competent, but what I know is that I can use those, I can use ICT, but I can't say that I am that much competent, because there are some of the things that I was never exposed to".*

However, she maintained: *"... Yes, it really helped me, because in most cases during the lectures the lecturers they don't elaborate more. They just give you maybe some hints and short notes. So I have to go there and search more information".* This indicated the relevant contribution made by ICTs to the conceptual understanding of issues discussed in class.

Participant (S3), on the other hand, claimed to have mastered the skill of surfing the internet for information – a lifelong skill that one can indeed develop for oneself with little help from lecturers and the institution: *"I think with the internet, I think the internet is the one which is popular and even though I am retiring, then I can still have access to the internet and read and find current information".*

He further claimed:

*“Mostly we use the internet and then in the internet when you search a topic there, then you will find different sources which bring different ideas. And then in that way then it is then I am able to get a lot of information and then different ideas and then at the end when I combine them, then I find something solid”. (S3)*

This indicates resourceful use of ICT to maximise learning potential and accrue the benefits of it for conceptual understanding. The student noted the dramatic progress made in ICT competency, when measured against his or her school background. This is portrayed in the following comment:

*“As you can see during the secondary, we only received, as I indicated, we only received the textbooks. They were limiting us and then now if I get a topic or I get a topic from the class, and then I can go further. Then I get into the internet and then I search the topic and I will get a lot of information”. (S3)*

Respondent (S4) used various sources and opinions to arrive at an understanding. This is reflected in the comment that:

*“... let’s say for example I am looking at the concept energy, I look at what is this book saying about energy or the concept that are dealing with energy. Then I go to the internet...”.*

Obviously the internet is a very comfortable digital zone for many student teachers seeking information, and they are well equipped to use it to contribute immensely towards their knowledge development. The respondent went on to comment:

*“Like most of the time when you Google the internet, it will just put a simple statement. There will be certain page ask.com, and then people will have to ask the same question. I look at the book; I look at those answers and then I Google more. Some you will find that they are just.., even when I say lecture notes, it is going to give a lot of lecture notes from different universities’ lecturers about the same concept and then from there I can this guy is talking about this things and about this thing. Sometimes I will find that the only difference is the terms they are using there”. (S4)*

Thus, students make use of search engines to obtain a variety of materials, and to analyse other people’s views on similar issues. In this way they consolidate conceptual understanding and demonstrate a creative and effective use of technology to support learning.

This respondent claimed to be well equipped to use the internet:

*“I was well in advance with the internet and stuff like that. So during first year, they will give us an assignment, and guys look at the books. When they are not giving you sufficient information, I will go to the lab and search for the information”*

- and professed to make use of ICT collaboratively:

*“I am going to be teaching science. I know that sometimes there will be some concept in science or some chapters that I am not vast with them or I am not good at. So with this ICT I can also communicate with my colleagues, you can say help me here” (S4).*

This participant seemingly depicts some level of capability and makes use of resources to advance learning.

Participant (S5), although not equipped by lecturers with ICT proficiency, through personal effort has learnt to engage with available resource tools for conceptual understanding and skill development, and is ready to employ these tools in future endeavours:

*“Even though I did not have that much exposure, but like one is the cell phone, because everyone now has got a cell phone. So cell phones can be used purposefully” (S5).*

The respondent seemingly agreed with the notion that competency comes about when one regularly engages with such tools for improved knowledge about them: *“Competency comes along with engaging regularly with what you are doing, but so far I have realised that I can be able to use ICT devices into my practice”*. However, this self-developed competency may have limitations, since the practice of skills may be possible only in a particular dimension and scope.

The participant expressed attachment to ICT resource tools and acknowledged the ease with which it enables one to access information, as well as its handy nature – as reflected in the comment:

*“ICT makes me to be closer to my learning. Using it, it is more easy and flexible other than maybe relying on textbooks and other things. ICT is just at your disposal. No need for too much stuff. It is only you and the device. So it makes it simple and easy”. (S5)*

The student saw the beneficial impact of ICTs on learning and conceptualisation, and went on to recommend the use of resource tools, like cell phones, to obtain academic materials: *“...So we can use those, like cell phone facilities, to get to access to those resources other than saying we don't have enough textbooks, whereas we do have portable devices*

*that can help us to download resources*". In this way, the participant showed how ICT resources could be used to advance conceptual development in a system with insufficient hard copy materials.

Another participant (S6) claimed to have strategically developed capability and confidence in using ICT tools on his own:

*"I am confident enough in using the laptop and computer. Actually the laptop, my knowledge on the laptop, it enables me to help people. The time I got used to the laptop it became so easy, because it was a new thing to me and I just tried everything that I could learn from and when it comes to presenting, the project I am not well equipped with it, but I just learn by trying"*.

Through practice this respondent became conversant with the technology and uses the tools to study: *"...in maths sometimes I come across worksheets on the internet and they give me the problem and they say provide the solution and submit and then they give you the feedback"*. In this way he demonstrates how to use technology efficiently and effectively to monitor learning progress.

It is worth noting that only a few of the student participants were exposed to ICTs at school level. Nevertheless, engaging with the technology at the tertiary level through the performance of tasks had contributed immensely towards them maximising the benefits of digital technology. Their enthusiasm to advance their competency in the use of ICT, to construct knowledge and develop skills, helped them to integrate these tools into their learning, to the extent of using them to evaluate their academic progress.

#### **4.5.4.2 Availability of ICT resources**

The role of the institution in contributing to students' ICT skills development cannot be underestimated, since it controls and monitors the digital facilities available to both students and teacher trainers. One of the main resources put in place by the institution to advance academic delivery and develop ICT skills is the 'Blackboard' system. The institution, through the IT section, provides support for lecturers to become familiar with the system's technology, as well as structuring their materials for placement on the 'Blackboard'. The value of the system has been described as follows:

*“...You will find that now students can be able to interpret their lecturers. They can be able to discuss, because some of the students they are afraid to talk to you face to face, but when they, you know use the discussion to interact with the lecturer, it is safer...” (IT1)*

It is therefore an attempt to make learning accessible to all categories of students, and to bridge the gap between lecturers and students by improving communication between them.

Secondly, with technology evolving so rapidly, the institution has decided to go a step further with the ‘Blackboard’ system, by introducing a mobile accessible component which enables lecturers and students to engage with ‘Blackboard’ via their smart phones: (IT1) *“In future like now we are looking forward to the mobile and especially the cell phones. Mobile where the students can be able to see the content on their cell phones. They don’t have to rush to the lab...”*. This is a positive step forward, propelled by the recognition that learning can take place anywhere and anytime. It is a clear expression of the flexibility of ICTs in creating a personalised learning interface, and thus promoting effective learning.

However, the students claim to be left behind; as one student commented:

*“Actually I don’t have a clue of what “Blackboard” is, I have never used it, and I do not know anything about it, although I am very much aware of it because I heard my colleagues talking about it. The ones who are in the other streams they have been trained for that. So I heard them talked about it, but I have never used it and I have never seen them used it”. (S2)*

Another respondent added:

*“Yes the ‘Blackboard’ is good; the problem is like not all of the students are covered. It is only a certain group that was somehow equipped with “Blackboard” and some groups were not bothered about. We just heard it before that there was going to be “Blackboard” and after that it came we never heard anything about it anymore. Sometimes when you go to the computer laboratory is closed and you find students logged on the computers and they are busy with it, but they never logged onto ‘Blackboard’”. (S6)*

Despite the positive side of technology-driven instructional strategies, there was the fear that technology-based tasks could result in a reduction in both interaction and direct contact with lecturers. This could alter the ‘norms’ of the lecture room, so that students with good technical skills become expert advisors to the lecturers and their

peers, which may either encourage or discourage colleagues and the learning process.

Also, from the interviews with students, it came to light that the institution has provided computer laboratories with internet facilities running at all times, but that this provision is inadequate. The students contend that in most cases they have to queue to have access, and this interferes with their acquisition of appropriate skills. Because of this, those who could afford had been obliged to purchase personal laptops, while the institution provided an accessible internet and Wi-Fi service for use on the laptops.

#### **4.5.4.3 ICTs as tools for learning**

Notwithstanding the integration of ICTs in the ITE mathematics, science and technology curriculum, so as to enhance conceptual understanding, the participants described other benefits this has had for teaching and learning. One student participant commented:

*“ICTs make me to be closer to my learning. Using it is more easy and flexible rather than relying on textbooks all the time. The other thing is that ICT is at my disposal. No need for too much stuff. It is only you and the device, so it makes learning easy and simple. Actually it makes me to be attached with the content and also issues arising out of the society”. (S5)*

Seemingly, the use of a variety of teaching-learning resources has the potential of enabling students to understand the subject matter more easily, at least in part, because of the different perspectives they encounter:

*“On the internet there is different software, like if am doing mathematics, as I come across a problem, there are calculators (programmes) that can show every step. Like there is a calculator which deals with integration. Then when you just punch the problem into that calculator (programme), it will give you step-by-step procedure of how to get around the problem”. (S3)*

The use of such programmes tends to be more fruitful when it is lecturer guided and the student possesses adequate technical skills.

ICTs also simplify learning, enhance students’ understanding of different abstract concepts and make them more active in achieving their learning objectives. As one student put it:

*“... I write down concepts that I do not conceptualise in class and Google it for opinions from others and how they explain it. At the end I obtain a clearer picture of such concepts”. (S4)*

The students also view ICT applications as reducing the gap between themselves and their colleagues and lecturers, through collaboration, discussion forums and chat rooms. At the same time, they claim they tend to lose focus and spend substantial time engaging in social chat, instead of academic discussion!

The students appreciate the way in which working with ICTs facilitates learning; yet they fear it may encourage an over-dependence that reduces the use of natural intelligence to solve basic problems. As one student commented:

*“I can say that I believe in ICT. I love ICT too much. I spent most of my time in front of the computer. Nine hours a day approximately I spend in front of the computer, but the problem with ICT is that once you become addicted or hooked to it, then it becomes a problem, because everything you want to do, you want to do it via ICT and now it becomes a challenge”. (S4)*

This addiction to ICT and substantial cost of time could be reduced and diverted to other academic activities if lecturers played a leading role, effectively engaging with students and using the facilities to transform the learning environment and social space.

#### **4.6 SUMMARY**

This chapter has provided a comprehensive analysis of the qualitative questionnaire and interview data from the students and lecturers, the two main components of ITE. Some of the major issues in this section of the study are summarised below.

Firstly, the socio-demographic characteristics of both the students and lecturers were explored and displayed. This included their social, cultural and academic status, gender, experience in tertiary environment and pre-university educational background. The students who participated in the research were all in their fourth year and the findings indicate that they had spent a minimum of four years studying for this programme and in the institution. They should, therefore, have adequate knowledge of the ICT facilities available, and the various resources. The lecturer participants hold a minimum of a master’s degree with four or more years teaching experience in this programme. They, too, should therefore be familiar with the available ICT resources and should be using some in their curriculum delivery.

Secondly, data on lecturer participants' epistemological and ontological assumptions, which determines to some extent how they integrate ICTs into the teaching and learning process, was analysed. The participants demonstrated knowledge of basic ICT tools and showed understanding of how these facilities could advance teaching and learning; yet their competency and confidence levels left much to be desired. They identified the "Blackboard" as an emerging productive tool for teaching and learning, but one that was not being used to its full potential due to the poor knowledge base of the lecturers and the students.

It also emerged that computer mediated communication (CMC) was popular amongst the participants, yet used mainly for social discussions, with limited academic use. The students contend that CMCs, if used in lectures under proper guidance, could assist them in learning, but not in the present circumstances in which they use them. One other issue highlighted was the use of mobile devices, especially cell phones (smartphones), which, if correctly used, could be a significant learning tool; yet there was no understanding of how and when they might appropriately be used. However, few lecturers feel that using mobile phones for academic purposes would infringe on students' social space.

A third issue that came up was the debate around the use of technology to advance quality teaching and learning, and for conceptual understanding. The participants claimed to have the capability and cognitive proficiency to access appropriately, use, develop, create and communicate information with few ICT resources available to them. They, however, admitted that a lot more has to be done for ITE students and staff to obtain the full benefit of ICTs in curriculum delivery.

Pertinent to the data was the students' personal contribution towards their skills development. Their attitudes towards technology, favourable or unfavourable, play a central role in the conceptualisation and efficient use of ICTs as a medium to enhance learning, conceptual understanding and skill development. Other issues highlighted included resources and tools at the participants' disposal, and what they are familiar and conversant with.

Also prominent was the lecturers' role in ICT integration into curriculum delivery and skills development. The data suggests that lecturers could contribute immensely towards an ICT-integrated revolution in teaching and learning if they were digitally

capable, ICT pedagogically confident, and could use ICT resources efficiently and effectively. The institutional contribution in the adoption and integration of ICT in teaching and learning also came under the spotlight.

Lecturers' perceptions play an important part in their adopting and adapting, integrating and embedding the usage of ICTs in curriculum delivery. Efficient and effective integration requires pedagogical transformation for new technologies, in terms of which its advantages are perceived to far outweigh its disadvantages. Using a variety of ICT resources could support teaching and learning, improve conceptual understanding, and contribute to confidence and competency development, especially with the current explosion of student numbers in mathematics, science and technology education. It is no exaggeration to say that the implementation of strategies that make effective use of ICTs is inevitable, and will have to be supported by effective pedagogical application.

## **CHAPTER 5**

### **DISCUSSION OF FINDINGS**

#### **5 INTRODUCTION**

This chapter presents and discusses the research findings that emerged from the analysis of the in-depth interview and the questionnaire data.

The discussion in this chapter is organised along the main findings of the study. These are: (1) ICT integration into teaching and learning (2) Ontological and epistemological orientation (3) Innovative and creative use of ICTs and (4) Conceptual understanding and transformative potential of ICTs.

#### **5.1 ICT INTEGRATION INTO TEACHING AND LEARNING**

One of the aims of teacher education in the 21<sup>st</sup> century is to develop skills and appropriate knowledge for student teachers to infuse technology into their future professional practice. It is, therefore, important for every lecturer in ITE to identify and know how to use ICT as a tool, and to appropriate their ICT pedagogical orientation for successful integration into classroom practice. It is evident that merely introducing technology into curriculum delivery is not adequate. Therefore, it is important to ensure integration, since ICT by itself will not effect change. Rather, it is the way in which lecturers integrate technologies that has the potential to bring change in the teacher educational system. In fact, ICTs have permeated the educational environment and are affecting or transforming teaching and learning experiences (Rapetti & Cantoni, 2012; OECD, 2012, cited in Fanni, Rega, & Cantoni, 2013). In this context, the integration pedagogy of lecturers should be aligned towards contemporary learning themes.

It is clear from the analysis in chapter 4 that the computer literacy course, that is intended to provide basic ICT skills to students, does not equip them adequately to effectively integrate these resources in the 21<sup>st</sup> century digital space. This indicates that ICT in ITE is considered as a transversal subject, which intersects the subjects, but causes nobody to feel responsible for its proper implementation. This has a negative impact on the students' use of ICT in their studies. This issue is analogous to Karsenti, Raby & Villeneuve, cited in Ananiadou & Rizza's (2010) findings,

discussed in chapter 2. The paradigm that underlined the method of delivery is that of transmission, since the course is treated as a subject that must be passed, and as such, construction of knowledge for future use is relegated to the background.

It appears that a process of 'pedagogical evolution' (Hennessy, et al., 2013) is taking place where there is a gradual, but perceptible, shift in teaching and learning practices of both students and lecturers in developing new strategies, in response to new teaching experiences. Some lecturers appear to be exploiting new technologies to support students' learning, and possibly helping students to reach higher levels of understanding' (cf. chapter 4). This finding corroborates that of Hennessy, et al., (2013), that new technologies initiate 'pedagogical evolution' in those teachers and students who embrace it.

Whilst the focus is on the pedagogical integration of ICT into teaching and learning, it is interesting to obtain findings from data on lecturers' and students' understanding of ICT integration, and their ability to identify productivity tools.

### **5.1.1 Understanding of ICT integration in teaching and learning**

Lecturers' understanding of ICT integration was oriented toward teaching and learning *from* computers, rather than *with* computers. This was the case, even though they could identify other ICT tools. It was seen in chapter two that pedagogical orientation can lean towards two main learning paradigms, namely the behaviourist and the constructivist. Integrating ICT according to a behaviourist frame lends itself to learning from computers, which is a transmission approach.

It is interesting to note that most lecturers' understanding of ICT integration is reflected in their computer-based instructions, computer assisted instructions, and the use of intelligence learning systems, mentioned in the data in chapter 4. This understanding, which informed their approach to integration, sees ICT as an instructional tool, and results in passive learning. This evidence corresponds with what was noted by Harris and Rea (2009). In a technology dominated educational system, learning and teaching from technology must be at the lower end of integrating ICTs into teaching and learning.

On the other hand, few lecturers, whose understanding leans towards a constructivist paradigm, promote learning with computers. With the underlying dialogic, constructionist and co-constructionist pedagogy provides opportunities for interaction and construction of knowledge through problem-solving tasks for conceptual development and critical thinking. Thus, it can be interpreted that these lecturers operate in a framework that describes a type of teaching and learning design and environment in which technology can amplify the principles of the 21<sup>st</sup> century learning agenda and create meaningful learning. This correlates with Jonassen Peck and Wilson's (1999), Ross, Morrison and Lowther's, (2010) views that learning with computers depends on lecturers' use of new technologies to create meaningful learning.

In this case, computer technology is mainly used as a cognitive tool, and within this domain the lecturers provide opportunities for the students to construct knowledge with technology, as opposed to merely obtaining information from computers.

### **5.1.2 Identify productivity tools**

It is clearly revealed in chapter 4 that lecturers identified productivity ICT tools available to them and showed that they had some knowledge of their use. However, they concentrated on the use of computers. Similarly, the students were capable of identifying productivity tools and resources and engaged them in their learning process and appeared to be aware of more ICT tools and resources than the lecturers. Data analysis also confirmed that, without the aid of the lecturers, the students do not adequately develop the key contemporary learning skills of communication and collaboration, creativity and innovation, research and information fluency, critical thinking and problem-solving and the authority of digital citizenship.

The productivity tools that were identified in the data for teaching and learning include; learning management systems such as Blackboard, computer technologies, including the internet, word processing software and presentation resources, social media and mobile devices such as the smartphones, tablets and the iPods, and lastly the Wi-Fi facility.

### 5.1.2.1 Learning Management System

The identified learning management system that is available to both students and lecturers is the Blackboard. The Blackboard system is an issue of contention amongst lecturers, with contrasting views on its use in teaching and learning. Some lecturers believe it establishes a knowledge construction environment for students' self-discovery and problem-solving. This could be achieved if used at a second level, but not at the present level of its use. Others perceive it as a medium that would encourage lecturers and students to absent themselves from classes, since all that was required would be pasted on the system. This demonstrates insufficient knowledge and understanding of the effectiveness of the productivity tool, and also shows the influence of their epistemological and ontological underpinnings.

On the other hand, some students are taken up by it, and claim it provides a flexible learning environment, while others do not. As mentioned in chapter 4, some students have little knowledge and education on the facility and, as a matter of fact, do not understand how the system operates. Can it be true that they were trained on how to engage with the service and were informed of its potential benefits? This issue needs attention.

The Blackboard system is meant to be used creatively in teaching and learning, and, if used effectively, students and lecturers may derive these potential benefits: increased availability, quick feedback, improved communication, tracking, and skill building (Bradford, Porciello, Balkon, & Backus 2007). However, the data that emerged showed that it is being used as a transmission tool. In this case, teaching resources, such as the course outline, course calendar, lecture notes, additional module resource materials, assignments, announcements and other communications, are pasted on the Blackboard for easy access. Thus, the Blackboard has been reduced to a 'cut' and 'paste' device and is not being used to construct knowledge, or to develop conceptual understanding. This is a limited use of the facility by the students and lecturers, and because of their pedagogical orientation based on their epistemology and ontology, they do not maximise the full potential of the system for teaching and learning. One cannot rule out the role of inadequate training as a contributing factor to the limited use of the facility, as evident in the data analysis.

It was surprising to find that ICT (the Blackboard) is primarily used to support existing teaching structures and traditional ways of curriculum delivery, and those ICT-supported systems which are largely supplementary to classroom teaching.

#### **5.1.2.2 Computer and computer-aided technologies**

This concerns computer and computer supported resources that are available to the respondents. These include presentation tools (data projector) and software, internet, discussion forum and chat room, tutorial software and the electronic mail system. It emerged clearly from the data that the respondents encountered two categories of computer and computer supported resources and tools.

First was a range of what the researcher describes as computer tools, notably word-processing, spreadsheets, dictionaries, encyclopaedias, tutorial software, social networks and the internet for the purpose of surfing and abstracting information. The study found that, of the many computer tools mentioned above, the respondents were familiar only with word processing software which they use to prepare teaching and learning materials, and the internet for surfing and abstracting information. Evidence of learning from computers dominates the use of the computer tools by the lecturers.

The second type that surfaced in data analysed in chapter 4, is the presentation software, such as power point and the data projector, which is a computer aided tool which happens to be very popular amongst the respondents. Again, the use of these tools is only for the transmission of knowledge, which does not challenge students' innovativeness or creativity.

The internet as a platform provides the opportunity for both studying and accessing information, or for teaching and learning in any place at any time. However, these tools, in many cases, are only used as repositories of educational examples, resources, links or files. Another predominant use is for social media activities.

It is important to understand that interacting with these tools in a passive way does not necessarily translate into using them to develop creative and innovative skills for easy learning; neither does it mean it automatically builds conceptual understanding.

### **5.1.2.3 Mobile learning devices**

Mobile learning devices are tools that empower students to embark on different pathways to build knowledge (Menkhoff & Bengtsson, cited in Singh, 2012). Mobile devices happen to be the latest learning tool (Biju, 2010). However, data shows that these devices are not permitted at lectures, which could be due to a lack of understanding of their use, and also the large generation gap that causes a technology divide between lecturers and students. Though some challenges were enumerated in the data, the benefits, if properly used, outweigh those drawbacks.

The study found that the lecturers were reluctant to use mobile networks for collaboration with colleagues on academic issues. The students use this resource also, primarily for social engagement, thereby negating its academic use. This suggests that the respondents are not familiar with the applications available within the technologies, and their focus is on information delivery instead of improving teaching and learning and thereby advancing constructive learning, as opposed to transmission delivery. This is consistent with Heirdsfield Walker, Tambyah and Beutel's, (2011) findings pertaining to the use of some of the new technologies.

According to the students, the convenient and strategic inclusion of new learning tools, such as smartphones and computers, creates a flexible environment which enables them (students) to switch between different interfaces and applications. This contributes immensely towards changing the teaching and learning landscape. However, it is unfortunate that most lecturers only allow limited use of mobile device during lectures.

Meanwhile, in the informal learning arena, the collaborative behaviour, networking concepts and approaches of students has played a transformative role in their learning process.

### **5.1.2.4 The Wi-Fi facility**

The Wi-Fi facility was introduced as another resource to match the dynamism in the present digital technological space. This is meant to be used for improving learning and teaching. The lecturers indicated awareness of the availability of the resource, but did not elaborate on how they use it in teaching and learning. The student participants, on the other hand, claim to make use of the resource to facilitate

learning. Furthermore, they (students) appreciate the availability of the resource and how it makes assessing the internet, and thus surfing for information, relatively easy (cf. chapter 4).

#### **5.1.2.5 Conclusion**

The findings and discussions thus far in this section reveal that the ICT resources and tools that are available to teacher trainers and student teachers are not adequately used to develop knowledge, as well as conceptual understanding, neither are they used for innovative teaching and creative learning. One must understand that education is gradually moving from a print-dependent age to a postmodern era influenced by electronic media. Hence, teaching methods and approaches have to change to accommodate the new generation of students.

## **5.2 ONTOLOGICAL AND EPISTEMOLOGICAL ORIENTATION**

Mathematics, Science and Technology Education lecturers showed some ambivalence in their ontological and epistemological orientation to using ICT. Some leaned towards the *instruction paradigm* and used ICT to provide instruction as a tool for transmission of knowledge; others leaned towards the *learning paradigm* (cf. chapter 2) showing awareness of the need to elicit discovery through ICT. Thus, the lecturers' knowledge settled on their sociocultural perspectives, proposed in Hodgkinson-Williams (2006) and discussed in chapter 2.

Data analysis shows that lecturers' ontological and epistemological orientation and low level of ICT skills and understanding of technology were some of the factors that contributed to their limited use of technology in teaching and learning. Though there are some resources that could be used in the delivery of the curriculum, not many lecturers incorporated the tools in this process. Furthermore, efforts were made by the institution to upgrade lecturers' knowledge and develop their ICT skills. However, it appears that the training offered was inadequate, not motivational and too challenging to make many lecturers feel confident enough to integrate technology in teaching and learning. There are others who are not in any position to change, due to their epistemological and ontological assumptions regarding the use of technology

in curriculum delivery. This finding corresponds with Lau and Sim (2008) that, despite acknowledging the benefits of ICT in teaching and learning, the learning potential of ICT is deprived due to lecturers' lack of sufficient skill and knowledge to engage the resources in curriculum delivery.

The students, on the other hand, seem to make self-propelled efforts to engage with ICT resources in their learning environment, though hindered by insufficient training and support from the lecturers and administration. Therefore, it may be argued that the ICT resources provide students with a limited set of potential functions because of insufficient skilling, inadequate training and their pedagogical perceptions. The instructional approach used by lecturers in teaching, pose no challenge to students to construct knowledge; instead, most of them get accustomed to it and operate within that frame. Hence, the students feel excluded from the profusion of technology in the current digital environment.

It was also noted that social factors, such as belief systems, affected the level of usage and the benefits derived from technology, such as the lecturers' refusal to part ways with the conventional routine embedded in their mode of teaching and learning. This could be due to a fear of losing power associated with the lecturer-centred approach, where the lecturer is perceived as the centre of knowledge transmission to a shared power domain. It is quite surprising that with the advent of technology which continually causes changes in the knowledge construction spectra, some lecturers are reluctant to improve their ICT knowledge base.

It was also revealed that some lecturers did not have sufficient technical support regarding the use of technology for teaching. This discouraged them from planning to use the technology, for fear of disappointment which could indirectly contribute to a reduced well-being and skill development of the students who are not receiving quality education.

### **5.2.1 Ambivalence in lecturers' ontological and epistemological orientation in using ICT**

The ways lecturers are taught relates strongly to the ways they later teach, influenced by their pedagogical orientation and coupled with ontological and epistemological assumptions. Ross, Morrison & Lowther, (2010) discussed how the

socio-relationship and partnership between the novice and expert determines how ICTs are used within a mode of operation (cf. chapter 2).

It was seen in chapter 4 that lecturers' orientation was ambivalent, suggesting that although they would like to use ICT effectively in a constructivist dimension; their pedagogical orientation restricted them to the behaviourist approach. This further suggests that the present generation of lecturers was exposed to conventional resources in their professional development. Hence, teaching in a contemporary space appears to be difficult for them, especially using new and advanced technological resources to approach curriculum delivery in a contemporary mode. They consider computers as merely for word processing and information surfing, and classrooms continue to run much as they did a generation ago. Thus, lecturers use new technologies far less in the classroom than they do at home. The considerably small numbers of teacher trainers that do use new technologies for instruction do so infrequently and unimaginatively.

It can be clearly deduced from chapter 4 that tension appears to exist for some lecturers between the desire to integrate ICT effectively, and their ontological and epistemological orientation. A potential factor of influence may be that most students have access to newer technology and make use of it in their learning process. However, a process of 'pedagogical evolution' does appear to be taking place gradually, with a perceptible shift in ICT integration practice and thinking. It is also evident from chapter 4, that some lecturers blend traditional and new ICT roles to present a curriculum, such as mixing didactic teaching with active learning.

Seemingly, lecturers continue to teach in a physical space designed for teacher-centred instruction. However, they are required to provide and manage an online learning environment with downloaded online resources, hence the chances of students not attending lectures is inevitable. Secondly, many lecturers consider the online learning environment as a complementary path to teaching; the students, by contrast, use it as a replacement for classes. This is evident from the data obtained (cf. chapter 4) from the respondents.

### **5.2.2 Paradigm orientation of lecturers in using ICTs in teaching and learning**

Although the lecturers operate in the same teaching and learning environments, their frameworks differ, depending on their pedagogical orientation, ontological and epistemological perceptions. Some have a framework largely underpinned by the transmissionist approach, while leaning towards a constructivist and co-construction approach. This concurred with Tay et al's (2012) description of the major categories of instructional use of computer-based technologies (cf. chapter 2).

In the study, lecturers expressed an awareness of student-centred learning and its potential benefit for students. Despite demonstrating good understanding, lecturers experienced difficulties operationalising this idea, since most operate in a paradigm that promotes teacher-centeredness. Secondly, the power dominance enjoyed by the lecturers as the custodians of knowledge would be minimised, combined with a possible changing role of the student. Furthermore, it appears that the teaching and learning physical space was designed for teacher-centred instruction, more than student-centred delivery.

The question is; will constraints advocating the pedagogical orientation of the lecturers' impact on the students' approach to learning? Surprisingly, data (cf. chapter4) showed that most of the students operate in a student-centred paradigm, operationalised within constructivism. Within the frame of a student-centred educational paradigm, the students take responsibility for their learning, with guidance from the lecturer.

### **5.2.3 Eliciting discovery through ICT**

On the basis of the empirical evidence from the study, there appear to be four main approaches to ICT used as pedagogical tools by both teacher trainers and student teachers. These are:

- Integrated context, where the respondents use ICT tools within the subject to enhance particular concepts through animation and simulations. Here students are confronted with challenges to their existing knowledge schemes, and in the process construct understanding and knowledge.

- Enhancement, based on a frame within which ICT resources are used to enhance conceptual understanding of a particular topic or issue being discussed, such as You Tube, and integrated into the lesson delivery, and presentations, thus promoting debate and collaboration. In this perspective, learning is enhanced through the presentation of knowledge in diverse ways.
- A complementary approach in using ICT tools to improve students' learning, such as the internet, to surf for information to support learning. In the same context, technology is used to advance learning by minimising routine and the repetitive aspects of tasks, thus focusing on more challenging ones.
- A supplementary medium where learning materials, tasks and other resources are loaded on to the learning management system, such as the Blackboard, for students to access and develop knowledge. However, some students and lecturers view it as a replacement for contact sessions.

It was striking to see how close the approaches that emerged from this study were to those found in Kemmis, Atkins, & Wright, (1977). However, none of the approaches employed in teaching and learning, that emerged, promotes discovery, though in some instances the students made efforts in that direction. For ICTs to be used to elicit discovery requires lecturers to have an extensive knowledge of ICTs so as to fit its use into their existing pedagogy, or to extend their pedagogical knowledge to make its use possible in teaching and learning. In this regard, the study obtained valuable input and suggestions, such as continuous professional development and training of students as critical for improved use of ICTs as discovery tools.

Findings from data also revealed that the levels of adoption and adapting ICT as a pedagogical tool to reflect the observed approaches, is dependent on the identified ICT productivity tool. However, these approaches do not seem to lead to eliciting discovery, since the objective here is the transmission of knowledge.

#### **5.2.4 Conclusion**

The study produced empirical evidence to argue that lecturers and students holding strong constructivist teaching and learning beliefs, in addition to self-efficacy, computer self-efficacy and a positive view of computers in education, were more

interested in integrating ICTs in teaching and learning. The finding is in accordance with Lin's (2008) studies involving pre-service teachers. This implies that the more constructivist the teaching and learning beliefs of lecturers and students are, the more confident and determined they are to integrate technology into curriculum delivery.

### **5.3 INNOVATIVE AND CREATIVE USE OF ICTS**

Lecturers do not use ICT to promote innovative and creative teaching. However, the students appeared to be more creative in using ICT resources.

The perspective of an ICT approach as a pedagogical tool, and available productivity tools, provides a conceptual base for this discussion. Consequently, a constructivist approach with the Vygotskian notion of dialogue engagement with technology for learning, discussed in chapter 2, served as a theoretical lens to examine the lecturers' and students' situations regarding ICTs for innovative teaching and learning. The conviction of using ICTs as tools capable of changing the face of subject content, problems and learning tasks, makes it a mediator of higher cognitive skills synthesis and analysis, critical thinking, evaluating, hypothesising, questioning and problem-solving, amongst others.

Therefore, to mediate learning approaches concerning how lecturers and students interact with, and manipulate, the ICT resources available to them, should focus on innovative teaching and creative learning to advance knowledge construction, conceptual understanding and skills development.

The study revealed, in chapter 4, that the use of social computing applications, such as blogging, sharing of a multimedia network, online gaming, and sharing of bookmarks (Citeulike), was inadequate and so did not help to develop creative and innovative minds. According to the literature, these applications demonstrate a variety of means to improve learning and offer new opportunities for students to express their creativity, making it available to a large audience, and getting feedback and recognition (Cachia, et al., 2007).

However, innovativeness and creativity can be cultivated and enhanced when an enabling environment and support mechanisms, such as training, education,

resources and encouragement from trainers through their creative and innovative approaches, are provided. In addition, students' creative and innovative learning has to be motivated with mechanisms and tools that help lecturers to pursue creative and innovative teaching paths and the students' active engagement in the creative and innovative process.

Seemingly, lecturers' sparing use of technology to advance their teaching, limits their knowledge and expertise, which in turn hinders students' eminently creative minds. Data revealed, in chapter 4, that if there is a change in cultural mind set and a shift of pedagogy from lecturers, students can be empowered to be more responsible for their own learning, and construct knowledge and to develop conceptual understanding using ICTs.

While the provision of ICT resources and tools continue to expand and provide different approaches for dissemination of course content and materials to students, it also emphasises the need to enhance active learning, research oriented learning and teaching and collaborative teaching and learning. With the focus on fostering student independence, self-reliance, self-motivation, critical abilities, creativities and others, as discussed in chapter 2, lectures appear to hold on to their traditional paradigm that encourages transmission of knowledge, as seen in chapter 4. This approach does not promote innovative teaching, and hence creative learning. However, the students seem to make an effort to be creative in their learning process, especially using presentation tools and mobile technologies for collaboration.

### **5.3.1 Lecturers ICT usage and practices**

As seen in the analysis (cf. chapter 4), lecturers appear to make limited use of ICTs in their curriculum practice, especially in teaching and learning.

It is widely expected that the technical performance of ICT tools will dramatically improve and widen the spectrum of teaching and learning. However, there has been a relatively slow and limited use of different technology tools and resources in teaching and learning practice, which in this instance, makes the expectations of ICTs to revolutionize teaching and learning over ambitious and exaggerated.

The most commonly reported use of ICT for teaching, included preparation of modules and teaching and learning resources, as indicated in chapter 4. Such a level of ICT use does not enable lecturers to radically change their pedagogical practices. In fact, there is a need to extend beyond their ICT use by engaging the students, with the aim of transforming their practices and improving their learning approaches. This corresponds with findings of Mwalongo (2011) discussed in chapter 2 of this study.

New technologies, such as the social web and re-oriented methodology paradigms, are envisaged, to transform the scenario of learning systems, such as exploratory learning through tasks given to challenge students' cognitive framework. However, data presented in chapter 4 revealed that the lecturers exclude social web and media from their teaching practice. They neither take advantage of it to collaborate with colleagues with similar specialisations, to improve their content knowledge and delivery, nor do they use it to engage students in learning.

### **5.3.2 Students ICT usage and practices**

It was astonishing to realise how students acknowledged the transformative role of ICT in their learning. However, they do not use technology to engage in high level thinking activities, such as problem-solving and critical thinking. Rather, they use it to facilitate production of their work so as to effect tasks and enable refinements which are both low thinking activities. The most common use of ICT by the students was to sort through information to solve tasks issued to them. It is acknowledged that this use of technology does develop life-long skills, and the desire to learn more is prompted by the situation. Hence, in most cases, students' use of ICT does not create opportunities for mental processing and challenge, but for abstracting and reproducing. This practice differs from Jonassen, et al. (2010) who claim that people learn from thinking, and thinking mediates learning, therefore learning is a product of thinking (cf. chapter 2).

It also emanates from chapter 4, that the students' engaged in sharing information with peers and considered it to be constructive, thereby contributing immensely to their learning endeavours. This indicated that the students operate in a constructive learning environment, where they take some control of their learning, using social

collaboration. In this respect the conceptual use of technology contributed to cognitive development, thus enhancing the acquisition of generic cognitive capabilities.

Most of the students seemed to have integrated technology devices in their academic routines to download information from the internet, to communicate with peers and to access digital learning resources. It is difficult to establish whether these uses actually contributed to the effective use of technology in a constructive learning space.

Notwithstanding, the discussed usage of ICT, most lecturers and students use technology to surf information, as the dominant activity thus shifting the focus from other possibilities which ICT offers for teaching and learning. Research shows that ICTs offer unprecedented opportunities for additional and different kinds of communication (cf. chapter 2) in social and academic spheres.

#### **5.4 CONCEPTUAL UNDERSTANDING AND TRANSFORMATIVE POTENTIAL OF ICTs**

Lecturers did not give ICT based tasks that promote conceptual understanding. They gave tasks that asked students to extract and reproduce information from computers, without demonstrating understanding. When used this way ICT can be de-skilling.

The advance in technology across the world has had a revolutionary effect on knowledge production, dissemination and use (Singh, 2008). Initial teacher education has to adapt to the knowledge revolution by infusing ICT effectively in the teaching and learning process, with the aim of assisting students to construct knowledge and develop understanding of content in mathematics, science and technology. This section of the study is devoted to a discussion of findings relative to the engagement of ICT to develop conceptual understanding and its transformative potential.

Technology integration concerns change in the nature of subject practice and pedagogy. Most lecturers and students seem to use ICTs to support, enhance and

extend existing classroom practices, such as exploiting technology's role in facilitating investigative learning and accessing a broader range of information sources. However, they do not employ dynamic visual representations, such as simulations or videos, to improve students' understanding of difficult concepts; hence they do not go beyond established practices (cf. chapter 4).

#### **5.4.1 Use of ICT for knowledge construction and conceptual understanding**

In their use of ICT lecturers emphasised the acquisition of knowledge and skills, and not the construction of knowledge. Tasks must be mind-provoking and challenging. It appeared that most lecturers' ICT knowledge restricted them to operating in a sphere that encouraged basic use of technology to mediate learning for the acquisition of knowledge, and not its construction.

ICT and the mediation of learning from knowledge construction and conceptual understanding is strengthened by the constructivist framework. The understanding here is that learning results from the construction of knowledge through interaction with the physical and social environments. This indicates that knowledge and experience play an important role in thinking, which leads to conceptual understanding. Contextualisation means that learning concepts must take place in real-life settings, or in a situation simulating real-life instances or context. It can be seen from data analysis (cf. chapter 4) that using ICTs to create simulations to learn more practical skills has not been part of the lecturers' teaching and learning agendas. Therefore, lecturers hardly engage in such activities in their curriculum delivery.

Interestingly, the study found that only a few of the students and lecturers contextualise concepts for manipulation and deeper understanding, whilst the majority conceptualise from the raw information, using search engines to obtain others' views on difficult concepts. Similarly to Lavonen (2008), the study identified that the learning setting that allows for authentic and real-life learning experiences, which enable students to treat concepts in various contexts and thereby deepen the meanings, is lacking. It is worth noting that engaging these activities in teaching and learning could contribute towards meaning-making and the necessary skills the students require in order to be capable professionals in the field.

The study argued that the students learn best, when contextualising concepts, if the lecturers engage them effectively and efficiently in doing so. This is a skill that cannot be easily developed without guidance and illustrations.

One other finding is that the students surf the cyberspace for information anytime they are solving difficult problems or concepts that are not well understood in class. This promotes innovation and broadens students' understanding of the subject matter. However, the proper use of the resources is what makes an impact and this tends to be more fruitful when they are guided by the lecturer.

#### **5.4.2 The transformative and constraining potential of ICT based learning activities**

In a constructivist learning environment, the lecturer and ICT oriented activities have transformative and constraining consequences for different users, and teaching and learning styles. This implies that modern technology use can skill and deskill users in different circumstances. It appears that students were keen users of new technologies; many seem to enjoy the novelty of the resource, value its efficiency, or are motivated to explore and experiment with various applications, even though some are frustrated by their lack of expertise. However, being enthusiastic about using technology, and praising the positive aspects does not exclude the fact that it also has disadvantages. Therefore, new technologies, if used and applied constructively, can produce positive transformation. However, if not used efficiently, they could be detrimental. In all these situations, the lecturer's role is important and significant in the learning potential of using ICTs in the teaching-learning process.

The fact that all the participants believed that computers enable hands-on opportunities (to some an intrinsic motivator sufficient to engage them in learning tasks) and contribute to knowledge construction, is an indication that ICTs play a transformative role in educational delivery. Further, the use of technology creates different learning approaches, resulting in different attitudes to learning, levels of motivation and engagement, construction and consolidation of knowledge, and therefore to different attainment levels. This falls in line with what was established in the Becta (2009) research report. Data also provides evidence that ICTs become more beneficial if used as constructive learning instruments that demand the use of higher cognitive strategies by challenging students' thinking.

Technology in education has brought with it new skills and challenges. These challenges are embedded in some activities that limit knowledge and skill development. Constraining potentials of ICT based activities revealed in the study; include the surface learning approaches through tasks that involve reproducing information, and memorising information, or where the students' sole intention is to complete the task, resulting in low-level thinking. ICT is a constructivist perception that applauds an autonomous and deep learning standpoint, hence, its use in learning activities that do not amplify knowledge and thinking deskills. One other activity that emanated from the study is the 'cut and paste' syndrome. This is a dominant activity and has reduced the quality of academic writing, and diminished self-initiated thinking ability.

When learning tasks provide limited opportunities for students to engage in constructive thinking and understanding, most of them become disorientated, and they become passive learners. Though ICT has been regarded and acknowledged as a tool to transform thinking and learning through a constructive approach, it can also produce deskilling. Few higher cognitive thinking activities were evident in the study where ICTs were purposefully integrated with subject content; however in most cases, the intent was to reproduce, or regurgitate, information.

## **5.5 DOCUMENT ANALYSIS**

Analysis of the documents suggests that they were purposefully prepared for ICT use in education, and thus created independently of a research agenda. Consequently, they did not provide detailed information to answer the research question. This finding corresponded with Bowen's (2009) assertion on limitations inherent in documents. Furthermore, document analysis revealed that the national and institutional policies on ICT integration emphasised the use of technologies in teaching and learning, but failed to address the issue of implementation strategies, parameters and framework.

## 5.6 SUMMARY

The discussion of findings of this study converge around four principal contexts, with links to other salient issues identified in the data and analysis. The first strand concerns integration of ICT in teaching and learning, followed by the ontological and epistemological orientation of lecturers and students. The third finding is related to the use of technology for innovative teaching and creative learning, and the last one is the use of ICT for conceptual understanding and the transformative potential of technology. Each discussion began by defining the principal finding. The learning approaches were adopted and adapted, using ICT for teaching and learning, to stimulate interest, motivation, support exploration and experimentation with understanding and to increase digital capabilities.

It is important to understand that the effectiveness of ICT depends on the pedagogical orientation and beliefs of the user about integration, and the availability of support, not ignoring the epistemological and ontological underpinnings of the user. The discussion shared the epistemological and ontological conversation that emerged from the analysis which informs the integration of technology in educational delivery. The contemporary learning strategies immersed in the constructivist purview evolve around knowledge construction and conceptual understanding, which involves an active learning approach, acknowledgement of the relevance of what is being learnt, concern about social construction of knowledge, encouraging individual meta-cognition, and realising the important role of collaboration and the value of self-regulatory learning as paramount constructs. These constructs, in turn, shape pedagogical practices, teaching and learning organisation and the management of learning.

Thus, a consecutive approach to harness the powerful potential of using ICT to support learning in a constructivist domain, requires pedagogical transformation and enhanced constructive learning approaches for effective knowledge construction and conceptual understanding. Digital technology has come to be a part of educational delivery, hence all the necessary strategies should be employed to maximise its potential by equipping student teachers with 21<sup>st</sup> century skills for the digital society.

## CHAPTER 6

### SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

#### 6 INTRODUCTION

The previous chapter discussed the main findings of the research. This chapter presents a synoptic overview and summary of the main findings from the study, concluding with remarks based on the data analysis, and the potential contributions of the study. Further in the chapter, recommendations are tabled, and areas for possible research proposed. The chapter concludes with a brief reflection of the research journey.

##### 6.1 SYNOPTIC OVERVIEW OF THE STUDY

Chapter 1 provided an orientation of the study, and hence positioned the study. It also captured the ideas from other investigations on similar issues, internationally and locally, on ICT in school and tertiary learning environments. In conjunction with the literature review it provided the platform on which this study was conducted.

The chapter offered an insight into the study, indicating the importance of ICT in modern educational transformation, and the crucial role of ICT integration, design and environments that encourage cognitive learning and critical thinking through teacher trainers' conceptual and intellectual involvement.

Chapter 2 explored the literature and presented a robust debate on concepts and issues related to the study. The researcher engaged with the opinions and findings of different researchers and examines the situations where those studies were conducted. This allowed the researcher to identify an area of research interest that had not been covered in the study, and with understanding from the debates, the study was conceptualised and a theoretical framework developed.

In Chapter 3, the researcher discussed the philosophical assumptions and basic beliefs that underpin the research process, the nature of knowing and constructing knowledge, epistemology, ontology and pedagogy which are the central focus of the study. The researcher then provided an explanation of how the research was conducted, and discussed the methods and techniques adopted for the research. The researcher explained the rationale for using a qualitative approach based on the

philosophical understanding that is interpretive, which allowed him to make meaning of 'how' lecturers pedagogical orientation determined their integration of ICTs in teaching and learning. The tools used in the study were discussed, followed by an explicit plan of action. This plan included the techniques employed in the execution of the research; how data was collected and analysed. The sampling technique and the population were also discussed. The last part of this chapter discussed the research rigour as well as ethical issues pertaining to the qualitative research study.

Chapter 4 presented the data and the analysis. This was done in accordance with what the study aims to achieve in terms of the research sub-questions and the main question. The chapter began by presenting data on the demographic characteristics of the respondents and their ICT profile. The chapter also presented information on the respondents' ontological and epistemological assumptions, as well as their pedagogical orientation with regard to ICT integration. Data was gathered on how ICT is used innovatively and creatively in the teaching – learning process, and for knowledge construction and conceptual understanding.

In the analysis, the findings that emerge were discussed in chapter 5.

Chapter 5 presented and discussed the research findings. The discussion in this chapter is organised according to the main findings from the analysis. These are: ICT integration into teaching and learning; Ontological and epistemological orientation; Innovative and creative use of ICTs and Conceptual understanding and the transformative potential of ICTs.

In chapter 6, the researcher presented the summary of the main findings, conclusions and recommendations. Also included in this chapter is a brief commentary of his research journey.

## **6.2 CROSS-CUTTING ISSUES**

The previous section presented a synopsis of the chapters. This section gives a summary of cross-cutting issues that emerged in the study. These issues include; operational space and digital engagement, skills development and ICT resources, pedagogic and technical support and finally, monitoring and supervision mechanism

### **6.2.1 Operational space and digital engagement**

Students and lecturers are expected to use ICTs in learning and teaching, with the aim of constructing knowledge and producing student teachers competent enough to fit into the present digital environment. However, the teaching and learning environment appears not to challenge, encourage or promote the use of technology to improve knowledge and to add value to teaching and learning. To achieve the objective of ICT integration in teacher education, and to transform the teaching and learning of mathematics, science and technology education, requires an operational space conducive to digital engagement.

### **6.2.2 Skills development and the availability of ICT resources**

ICT skills development is central to competent and successful integration into teaching and learning. The white paper on e-education (2004) expects the new teacher to be equipped with the necessary skills to infuse ICT in their professional practice. Knowledge about various software and hardware and their use in educational activities and processes appears to be an issue of great concern to both students and lecturers.

### **6.2.3 Pedagogic and technical support**

It is clear from the data that lecturers and students lack pedagogical and technical support in infusing technology into teaching and learning. The unit responsible for providing these services happens to be embedded in the larger IT section, and has no autonomy to function independently. To maximise the benefit from this unit, therefore means that it should operate as a 'stand-alone' entity with the task of assisting lecturers and students to obtain the best out of technology.

### **6.2.4 Monitoring and supervision mechanism**

The university commenced its institutional engagement with ICTs in teaching and learning, by seeking to provide good technological infrastructure, and also supporting lecturers to use a learning management system (Blackboard). However, the use of the facility depends on the initiative of the lecturer and students. This makes the integration process difficult to monitor and supervise, and to be effectively managed.

### **6.3 SUMMARY OF MAIN FINDINGS**

In this section, the researcher provided a synopsis of the key findings from the qualitative questionnaire and interview analysis, as discussed in chapter 5. The analysis followed categories that emerged from the sequence of research questions that guided the study.

#### **6.3.1 ICT integration into teaching and learning**

Mathematics, science and technology education lecturers' understanding of ICT integration was oriented towards what Jonassen, Howland, Marra and Crismond, (2010); Young (1997); Ross, Morrison, and Lowther (2010) and Norton and Winburg (1998) call teaching and learning *from technologies*, rather than *with technologies*. This was reflected in the data obtained from lecturers on the way they give instructions to students.

However, it appears a process that Hennessy, Ruthven and Brindley (2013) refer to as 'pedagogical evolution' which is taking place, in that there is a gradual but perceptible shift in the teaching and learning practices of both students and lecturers.

#### **6.3.2 Ontological and epistemological orientation**

Lecturers showed some ambivalence in their ontological and epistemological orientation, using ICT in teaching and learning. Some leaned towards the *instruction paradigm* and used ICT to provide instruction as a tool for the transmission of knowledge; whilst a few leaned towards the *learning paradigm*, showing an awareness of the need to elicit discovery through ICT.

#### **6.3.3 Innovative and creative use of ICT**

The key finding here is that lecturers do not use ICT to promote innovative and creative teaching. However, the students appeared to be more creative in using ICT resources.

Lecturers and students appear to use ICTs for finding information as the dominant activity which shifts the focus from other possibilities which ICTs offer for teaching and learning.

#### **6.3.4 Conceptual understanding and transformative potential of ICT**

Lecturers seemed not to take advantage of available resources to give ICT based tasks that could promote conceptual understanding. They gave tasks that asked students to extract and reproduce information from computers, without demonstrating understanding. When used this way ICT can be 'de-skilling'.

Lecturers do not employ dynamic visual representations, such as simulations or videos, to improve students' understanding of difficult concepts, and hence do not go beyond established practices.

#### **6.4 CONCLUSION**

It can be concluded that many of the mathematics, science and technology education lecturers' integration of ICT in teaching and learning is within the behaviourist perspective, which takes the form of an instructional tool and not of problem-solving and critical thinking. However, to produce teachers ready for the 21<sup>st</sup> century digital environment requires a pedagogical transformation or alteration within the constructivist belief system.

Furthermore, lecturers presently operate in a traditional learning and teaching space, but they are expected to teach in a digital domain. For integration of ICT to be successful, the teaching environment, technological resources and pedagogy have roles to play. This, however, can only happen based on their ontological and epistemological orientations to ICT.

#### **6.5 POTENTIAL CONTRIBUTION OF THE STUDY**

This study provides empirical evidence of ICT integration in a small sector of Higher Education. It uses ontological and epistemological as well as theoretical orientations of lecturers as lenses of analysis. The findings point to the fact that, through the perspectives that they hold, lecturers and students mediate ICTs and create meaning, and thus, learning. If ICTs are mediated by people with these attributes, the success, or otherwise of integration can only be judged by going beyond the capacities of technologies themselves, and factoring in the human element.

## **6.6 RECOMMENDATIONS**

Based on the findings of this study, the researcher would like to make the following recommendations:

### **6.6.1 For the integration of ICT into teaching and learning**

A framework for integrating ICT in ITE should be developed, stating clearly the underpinning paradigm for integration. The inductive thematic analysis of the documents on ICT integration at both national and institutional level provides a theoretical imperative and recommendation for policy intervention at both levels on ICT integration framework.

There should be emphasis on developing and sharing pedagogical expertise concerning ICT use in teaching and learning. Thus, lecturers would become more knowledgeable about ICT integration into teaching and learning.

Lecturers and students should have a better understanding of new technologies and their functional application in order to maximise their potential.

Knowledge improvement programmes on ICT integration should take into account the appropriate pedagogical approach relevant to the needs of the digital society.

There should be regular professional development programmes to upgrade lecturers' and students' knowledge on emerging ICT productivity tools.

Mentoring facilities should be readily available to support students and lecturers in integrating technology into curriculum delivery.

### **6.6.2 For further research**

Research focussing on the skilling and de-skilling aspects of ICT integration should be undertaken. Data from such research should be used to inform the practice of integration.

Survey research based on probability sampling should be undertaken, focussing on pedagogical issues in ICT integration in teaching and learning. With such a study, findings can be generalised for consideration by the sector.

## 6.7 PERSONAL REFLECTION

The researcher's passion to investigate the integration of ICTs in teaching and learning began in 2006 when the researcher was a school teacher. Seeing schools supplied with basic ICT facilities (computers) which were not being used for the academic benefit of the students prompted the researcher to think of possible factors that might contribute to teachers' inability to engage with the tool. The researcher's interest was overwhelming when, a DoE workshop intended to equip teachers to make use of computers failed to achieve its objectives, due to the teachers' poor knowledge on technology. Secondly, reading through the SITE 2006 project document on integration of ICT in education, which pointed out the poor state of ICT integration in schools, inspired the researcher to attempt to make a difference.

Three years ago, the researcher took the initiative to embark on this study and go beyond teacher related issues for non-use of technology, to a study of teacher training programmes to equip teachers with the necessary technology skills to integrate them into teaching and learning. The researcher got a lecturing position in one of the tertiary institutions involved in teacher training, and had the opportunity to engage, with practising teachers, on the issue, as well as observing first-hand the nature of teacher training programmes. It was clear that the source of equipping prospective teachers with ICT skills lay in their pre-service environment.

This three year journey saw the researcher drawn closer to the ICT practice of lecturers involved in mathematics, science and technology teaching in ITE, and to acknowledge the effort they make to integrate technology in their practice. However, much has to be done if student teachers are to meet the needs of the 21<sup>st</sup> century digital environment. Students appear to be fast incorporating ICT into their learning process, and demanding that lecturers do more to close the digital gap. Though the current integration of ICT is largely within the behaviourist paradigm, to effectively use technology, pedagogical reorientation has to take place. Regular lectures on professional development programmes would help address this issue and thus rescue the situation.

This journey has been long and tiring, but the researcher is proud to say that there were two strong supervisors who continually provided encouragement whenever

things got tough. The experience gained in conducting qualitative research and in-depth analysis of qualitative data will be transferred to other future researchers.

The integration of ICT into teaching and learning is not as simple as it sounds, but is a multi-complex domain which requires cooperation from all stakeholders in education. With the right people and the correct orientation, the full potential of this amazing resource could be used to transform education and produce students who will be ready for the demands of a knowledgeable society.

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**APPENDIX A**  
**RESEARCH QUESTIONNAIRE - STUDENTS**

**Date:** \_\_\_\_\_ **CODE: QS 01/02/03/04/05/06/07/08/09/10**

**Email:** \_\_\_\_\_ **Phone No:** \_\_\_\_\_

**INTRODUCTION**

This is a PhD research questionnaire which aims at investigating the pedagogical integration of Information Communication Technologies (ICT) in Initial Teacher Education (ITE) The purpose of the questionnaire is to determine how the ICT pedagogy of lecturers and students of mathematics, science and technology education influences the process of constructing knowledge and conceptual understanding. Kindly be as open and free as possible. Be assured that absolute confidentiality will be adhered to and under no circumstance will your detail information and any part of your response be divulged to a third party.

**INSTRUCTION**

Kindly respond to all the questions to the best of your ability. Your honesty will be deeply appreciated. Express yourself as much as you wish. The questions have been framed with care and consideration. However, if clarity on any aspect/issue is required, the researcher will be very willing to provide such assistance at any time. A follow-up interview (verbatim) will be organised by the researcher to address issues that may arise from the questionnaire.

**RESPONDENT DATA**

QS (a) Kindly talk briefly about yourself. (Name, Age and Date of Birth may be ignored)

\_\_\_\_\_  
\_\_\_\_\_

QS (b) What academic / professional level are doing at present?

\_\_\_\_\_  
\_\_\_\_\_

QS (c) What will be your academic / professional qualification after completion of studies?

\_\_\_\_\_  
\_\_\_\_\_

QS (d) What are the major subjects you will graduate in and what is your career path?

\_\_\_\_\_  
\_\_\_\_\_

QS (e) Give a brief background of your experience reading these (this) subject(s) and the course as whole.

\_\_\_\_\_  
\_\_\_\_\_

QS (f) How long have you been studying these (this) subject(s) and this course as well as studying in the institution?

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QS (g) Describe your experience of any kind of internship / practical teaching / field work.

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QS (h) Briefly share your experience of studying this programme in the institution.

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### RESEARCH QUESTIONS

QS1. Kindly tell me about your experience with ICT's

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QS2. The university has introduced the "Blackboard" service which is an ICT initiative. Workshops and courses were organised at different phases for both lectures and students. What is your take and experience of this service?

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QS3. How does the service ("Blackboard") influence your learning (Maths/Science/Technology)?

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QS4. How does the service ("Blackboard") benefit you as a student regarding your major subjects (application of knowledge acquired)?

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Let's move on to your personal use of ICTs' to advance learning for conceptual understanding, innovation and creativity and skill development.

QS5. How do you incorporate ICTs' in your (Maths/Science/Technology) curriculum studies and what challenges do you face in doing so?

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QS6. Discuss the benefits of incorporating ICTs' in your curriculum (Maths/Science/Technology) studies?

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QS7. How do you use ICTs to obtain curriculum resources for Maths/Science/Technology?

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QS8. Sharing knowledge and experience with colleagues in a discussion forum/group on the internet is a way of team building. Explain how this influences the progress of your maths/science/technology studies?

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QS9. Describe how you use ICTs to enhance your innovation and creativity.

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QS10. Explain how your ICT use incorporate real-world settings and application in learning?

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QS11. Discuss how you use ICT to promote personal and academic growth?

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QS12. Discuss how you incorporate the following in your learning programme (Mathematics/Science/Technology).

(i) Equipments and hands-on materials (projectors, internet, others).

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(ii) Tutorial software.

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(iii) Communication software (email, chat, discussion forum)

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(iv) Digital resources (portal, dictionaries, encyclopaedias)

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(v) Mobile devices (cell phone, iPods, etc.)

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(vi) Learning management systems ("Blackboard")

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QS13. How do you use the internet (select suitable websites, user groups, discussion forum) to support your learning (Mathematics/Science/Technology)?

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QS14. Discuss how you use ICTs for a lifelong oriented skill development?

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QS15. One of the traditional importance of ICTs is using it to conceptualise learning materials, complete exercises, assess your progress and feedback from lecturers. Explain how you use ICTs for the above and monitor your progress?

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QS16. How do you use ICTs in collaborative and cooperative learning in Maths/Science/Technology?

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QS17. Explain how you use ICTs to facilitate lifelong learning?

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QS18. Discuss how you use ICTs to increase learning motivation and making learning more of fun and interesting and individualise your learning experiences to address learning needs?

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End of questionnaire. Thanks for your time, which I acknowledge is precious at this time of the year.

**APPENDIX B**  
**STUDENTS QUESTIONNAIRE DATA**

QUESTIONS	RESPONSES	COMMENT
<b>PART A – PERSONAL INFORMATION</b>		
<p><b>QS (a):</b> Kindly talk briefly about yourself (name, age and date of birth may be ignored)</p>	<p><b>S1:</b> I am a young man who grew up in deep rural area of Sekhukhune in a family of eight. I attended both my primary and secondary schooling there. After passing my grade 12, I went to [REDACTED] to study BSc. After completing my degree I taught in a High school only for four months as a temporary educator of physical science. Then go to university to do postgraduate certificate in education in order to be a qualified educator. I believe that the best way of teaching learners is through discipline and by creating curiosity amongst them.</p> <p><b>S2:</b> I am a female who completed my matric in 2004. From 2005 – 2007, I was at Gauteng doing computer literacy and PC engineering diploma from certain FET college. January 2008 – December 2008, I was Love-Life educator giving health talks in clinics and local schools (primary and secondary). I am a hard worker who does not give up easily. I am a Christian and my hobbies are singing, cooking and reading.</p> <p><b>S3:</b> I am generous, kind, shy and loving to help people, socially about things that concern or related to education and in other aspect of life. I am a student at [REDACTED] campus doing education (Bed) and majoring in mathematics and science. I love maths mostly and I spent sometimes searching for jokes in the internet which are related to mathematics. One more thing is that I am passionate about mathematics and I want make sure that my future learners come to see mathematics as the simplest subject.</p> <p><b>S4:</b> Am a student at [REDACTED]. Currently enrolled for a Bachelor degree in education, majoring in Mathematics and Physical Sciences for senior phase and FET. Am very passionate about IT and Physical science (Physics). I matriculated in 2006, and 2007 went to university of Venda to study BSc Computer Science. Dropped out in 2008 for personal reasons and in 2009 enrolled for Bed which is what am currently doing.</p> <p><b>S5:</b> I'm ambitious goal-oriented young man who believes in the power of his dreams. Acquiring knowledge is at the core of my entire being. I'm internally motivated to achieve my goals in all the spheres of life. Though sometimes academic spheres seem to be challenging, I hold unto my career and belief and have faith in God and talents that He gave me. I love studying and am curious in nature and above all I'm pregnant with success. I understand that I have to endure labour pains before I give birth to success. Achieving academic goal is a process which requires perseverance.</p> <p><b>S6:</b> I am the kind of person who strives to work to the best of his ability. I like science as much as I like mathematics but I struggle so much with science because I did not have adequate exposure to science at early age as compared to mathematics. I strive not to look down on other people, disrespect them and keeping all that I have to myself i.e. I like sharing and engaging with optimistic people and helping those who are in need. My search for success in mathematics is that every problem has a solution, no matter how complex the problem may be, the solution is there and I will find it through perseverance.</p>	

<p><b>QS (b):</b> What academic/professional level are doing at present?</p>	<p><b>S1:</b> I am currently busy with my postgraduate certificate in education with mathematics and physical sciences as my major courses at the university of Limpopo.</p> <p><b>S2:</b> I am a final year student doing 4<sup>th</sup> year.</p> <p><b>S3:</b> I am doing 4<sup>th</sup> level in Education (BEdspf).</p> <p><b>S4:</b> Currently doing level 4.</p> <p><b>S5:</b> I'm currently at the 4<sup>th</sup> level of Bachelor of Education degree.</p> <p><b>S6:</b> Presently I am in level four of my profession.</p>	
<p><b>QS (d):</b> What are the major subjects you will graduate in and what is your career path?</p>	<p><b>S1:</b> I will graduate in mathematics and physical sciences as my major courses and become an educator. But one day I wish to see myself a mathematics curriculum advisor.</p> <p><b>S2:</b> Physical sciences and Technology. I'm intending to do honours between one of my majors if I qualify, if not, I'm intending to correspond with Unisa and study Technical engineering (part-time).</p> <p><b>S3:</b> My major subjects are Mathematics and Physical sciences.</p> <p><b>S4:</b> Physical Sciences and Mathematics. Teaching career path.</p> <p><b>S5:</b> Mathematics and Physical Sciences. My career path is to be an expert in both mathematics and physical science education.</p> <p><b>S6:</b> The major subjects that I will graduate in are Mathematics and Physical science for educators. And my major interest rest in mathematics for educators for furthering my studies.</p>	
<p><b>QS (e):</b> Give a brief background of your experience reading this (these) subject(s) and the whole course.</p>	<p><b>S1:</b> I realise when doing these two courses (mathematics and physical science) one must have a solid background in these courses and understand the two subjects but not memorise in order to succeed. I myself was struggling with chemistry because I did not have a solid background in chemistry. One must have a sound knowledge of mathematics (working with numbers) even though he is doing only physical science.</p> <p><b>S2:</b> What I have experienced when reading these subjects is that they don't need someone to memorise. Technology for an example is more practical and for me to understand it I must read and don't rely on notes prepared by the lecturer. Same applies to physical science, it does not need memorization, you have to read and understand so that you can apply what you have read and understood. The course include subjects like Educational Studies which taught us about Curriculum and Management, Computer Literacy, Communication, Life Orientation and Mathematics to name few but these ones were not much demanding like the major courses.</p> <p><b>S3:</b> Mathematics and Physical sciences are two of the subjects that most learners consider to be complicated. In my experience these subjects are not difficult as they need a person who is learning them to be independent and self-reliant. What I have realised is that the way that lecturers and teachers teach these subjects may temper, that I am passionate about maths and I want to make sure that my future learners come to see mathematics as the easiest subject.</p> <p><b>S4:</b> Physical Sciences and Mathematics from year one, was no difficult since the content was more related to high school content and the lecturers always provide enough assistance and learner's guide for the modules which turn to be very helpful. The university also have computer labs where we can access the internet and search for information.</p>	

	<p><b>S5:</b> Mathematics and Physical science require lots of time than any other modules. It takes time for really process aspects of physical science, so as a result it requires lots of determination and will power. These subjects are more challenging and fun of course. My experience reading and studying these subjects is centralised on the use of various available resources at our disposal to really have deeper insight on the subject matter. The whole course is very interesting and challenging and it's a rewarding course. Everything we learn comes together to maths and science.</p> <p><b>S6:</b> My experience of studying or reading mathematics for educators and physical science for educators is that both of them are taught differently but are equally important. Mathematics for educators is rich in representations which are central part of imparting the knowledge of mathematics meaningfully to learners. Whereas in physical science the central part of it to become meaningful to learners is to get them have sense of context of the problem i.e. being able to draw a picture or sketch of the problem and labelling all the information in the problem then selecting appropriate strategy of solving a problem.</p>	
<p><b>QS (f):</b> How long have you been studying this (these) subject(s) and this course as well as studying in this institution?</p>	<p><b>S1:</b> If I can start from grade 10 up till now. I could say eight years. But when considering only at the university level this year will be my fifth year studying these subjects and studying at university of Limpopo.</p> <p><b>S2:</b> I have been studying these subjects and in this course for four(4) years. In my 1<sup>st</sup> year, second semester, I failed Technology and repeated it the following year and since then I have learned my lesson.</p> <p><b>S3:</b> With mathematics, I have been doing it since at my primary level but with this course; I started on the year 2009.</p> <p><b>S4:</b> Three years at High school (grade 10 – 12). Four years at this institution (1<sup>st</sup> year 2009 – 4<sup>th</sup> year 2012).</p> <p><b>S5:</b> I have been studying these subjects from my primary – secondary schooling and also at tertiary level. My learning process up so far has been maths &amp; science. Its actually 12 years of schooling and also 4 years of my degree (16 years).</p> <p><b>S6:</b> I have been studying this subject for a period of 4 years as well as studying in the institution since 2009 which is my first year and to date (2012) which is my final year.</p>	
<p><b>QS (g):</b> Describe your experience of any kind of internship/practical teaching/fieldwork.</p>	<p><b>S1:</b> When I was still a temporary physical science educator at high school, my challenge was making sure that the learners understand what I was teaching them. I realised that most learners like physical science but their attitude is not that of physical science or mathematics learners surprisingly even at grade 12 level. I had never come across problem of ill-discipline amongst the learners.</p> <p><b>S2:</b> What I have experienced during my practical teaching is that content knowledge only is not enough. To be a good teacher, you must know your content yes but you must also be able to apply (use) different types of teaching strategies so that all different types of learners are accommodated. Teaching is not easy but things are hard for a reason, and good things don't come easy. Regardless of the challenges, the rewards were so much more. Rewards such as hearing one of my students say after some days; 'have been taught technology in the past, but I have learned more today here than ever before'. I have experience that you have to show sense of respect and responsibility towards learners and colleagues and again you must corporate professionally.</p> <p><b>S3:</b> I have experience on the practical teaching. Out in the schools there are numerous and different kinds of challenges, which may be socially or academically. Learners come to class with different views</p>	

	<p>or misconceptions but they need someone who really know the content to clear those misconception that hinder them from learning effectively. Some learners will challenge you with other things but they need someone who knows that those learners need who will treat them or act as a parent at school.</p> <p><b>S4:</b> I did practical teaching in various schools during my study of the programme. I was teaching both mathematics and physical science in various grades such as 2009 (grade 11 &amp;12); 2010 (grade 10 &amp; 11); 2011 (grade 9,10 &amp; 11) and 2012 (grade 9,10 &amp; 11).</p> <p><b>S5:</b> My experience with respect to practical teaching is so interesting as I had enough time to really understand my position as an ambitious goal-oriented and result driven facilitator. I did my practical teaching for 20 weeks. I slightly know the kind of environment that I will be working. I understand the society's expectations of me. The school at large is eager to receive what I have acquired in my tertiary level. These practical offered me an opportunity to interact with both teacher and learners at school levels.</p> <p><b>S6:</b> My experience of practical teaching is that teaching is noticed as a simple thing that anybody can do and is mostly criticized by many people. In my practical teaching, I realised that the criticisms are brought by not knowing the value or significant of teaching. Some of the greatest experience in my practical teaching includes realising that teaching a subject helps me learn a subject and not to underestimate or overestimate my learners else I will experience difficulties.</p>	
<p><b>QS (h):</b> Briefly share your experience of studying this programme in the institution.</p>	<p><b>S1:</b> Personally, I never had any problem when coming to mathematics. The problem was when coming to other additional courses as they were coming from other disciplines not mathematics and science.</p> <p><b>S2:</b> This programme is big enough for someone to study alone. Yes there are some courses that you can study alone but when studying in a group, there is much difference unlike studying alone. I realise that studying in groups helps a lot. Sometimes you might not understand something during lecture but only to find out that one of your group members understand better and can be able to help you. Again when studying in groups you gain lot of information unlike when studying alone.</p> <p><b>S3:</b> I enjoyed my time with/in this programme and I have learned a lot of things. Mostly I enjoyed mathematics and surely my future learners will learn a lot of things from me and they will find the best teacher. I was taught to be independent and not to rely on the teacher/lecturer, and now this is my objective when I teach my learners to ensure that all my learners are independent.</p> <p><b>S4:</b> The programme was challenging and equipped me with various skills and knowledge in the field of mathematics and physical science education. Some of the skills that I have acquired during the study are skills such as interpersonal skills, communication skills, computer skills and a change of attitude towards mathematics and physical science.</p> <p><b>S5:</b> The programme offered me an opportunity to understand all the major aspects of what teaching is all about – its more than writing on a chalkboard. These programme also provided me with a psychological aspects of both teachers and learners. Understanding how learners are and behave is imperative in about bringing good and effective teaching and learning. I have accumulated important aspects of pedagogical content knowledge which is at the core of any teaching programme.</p> <p><b>S6:</b> My experience of studying BEdspf is worthwhile and the one that I wouldn't have in any other institution. Most people believe in me and</p>	

	<p>always encourage me to always do my best when I can. The most enjoyable and exciting experience I gained is in mathematics for educators second level and third level including method of mathematics in level 2 and 3. Whereas in others, I struggle with them to ensure that I do not disgrace my potentiality. I was never sure of what to pursue in life but currently I know best.</p>	
<b>PART B – ICT BACKGROUND</b>		
<p><b>QS 1:</b> Kindly tell me about your experience with ICT's</p>	<p><b>S1:</b> ICT especially in teaching and learning environment makes the work easy. One easily search for supporting information concerning what he is currently studying. One can communicate with his fellow classmates easier using social network such as facebook, whatsapp etc.</p> <p><b>S2:</b> With ICT I am having a little experience, before coming to university. I have studied computer literacy and PC engineering from a FET college so when I came here I was having an idea about computer and its applications.</p> <p><b>S3:</b> I started experiencing ICT in this institution, because during my primary and secondary level the only resources that were being used are textbooks and calculators. I started to experience more of it in this institution. ICT makes it easy and possible for learners to understand, to get clarity and abundant of information even out of the classroom.</p> <p><b>S4:</b> Started using computer in 2004, during my high school days. Studied computer literacy as one of modules in the BEd programme. I have also worked at the university computer labs for a period of two years (2010 and 2011) as a general computer lab assistant.</p> <p><b>S5:</b> My experience is mainly on the aspect of self-study. In a teaching or classroom situations, I haven't used it. I used ICT mostly as an additional resource to acquire knowledge. Blackboard is one of the communication technologies I was exposed to, though few contact sessions were done. I couldn't learn much about such communication technologies as I couldn't receive proper instruction on how to use it to access module materials.</p> <p><b>S6:</b> I had only two to three chances for two weeks last year in my third level of study to access blackboard. Hence ICT assist me in many ways of which amongst most includes accessing internet service to search for information in preparation for lecturer contact sessions, writing assignments and also sending emails to school principal requesting permission for conducting teaching practical.</p>	
<p><b>QS 2:</b> The university has introduced the "Blackboard" service which is an ICT initiative. Workshops and courses were organised at different phases for both lecturers and students. What is your take and experience of this service?</p>	<p><b>S1:</b> Blackboard simplifies the work of the lecturer or the educator even though it kind of deskills the educator or the lecturer. It makes the course work looks easy from student point of view which sometimes misleads the students. It makes the lecture interesting and as the students we turn to concentrate during the lecture.</p> <p><b>S2:</b> I don't know anything about blackboard but I heard my fellow students from mathematics stream talking about it. I never had the opportunity to attend one of the workshops so when coming to blackboard service I am clueless.</p> <p><b>S3:</b> I have never had or attended a workshop which was addressing this initiative. But last year on my 3<sup>rd</sup> level, our mathematics lecturer introduced it to us. The reason we were introduced to this (blackboard) was to reduce the amount of contact with the lecturer in the classroom. We were receiving the materials and you can also send your concern if you have. But there are many features in the blackboard which we didn't do.</p> <p><b>S4:</b> Blackboard service provides an easy way to communicate and</p>	

	<p>sharing of information between the lectures and students. Lecturers are now able to send lecture notes, hand-outs or any study material online and students have access to this material anytime.</p> <p><b>S5:</b> Blackboard service is very important though I was not exposed to its content. As students we can interact with each other via blackboard without attending traditional classes. With blackboard, you learn at your own pace but still obey lecture rules of the content. Using blackboard can expose students to the use of internet service. Students can access material via blackboard.</p> <p><b>S6:</b> I had less than one month experience of using blackboard in 2011 for MATE 311. Since then I started experiencing password problems for login and when I was supposed to consult about the problem, some of the students I was attending MATE 311 with for which blackboard was mainly used for in our case told me that the lecturer says she was told the person who is responsible for helping us is no longer our assistance.</p>	
<p><b>QS 3:</b> How does the service (Blackboard) influence your learning (Maths/Science/technology)</p>	<p><b>S1:</b> it makes the course very interesting and looks easy than one can think. It gives students confidence in doing the course. As student we become more interested in the subject than when in the case of the lecturer or the educator sue the old traditional way of teaching or lecturing not the “blackboard”.</p> <p><b>S2:</b> it does not have any influence because I don't know what it is and how it works.</p> <p><b>S3:</b> It helps students to have time to study without the teacher. It encourages collaborative learning amongst the students. In “Blackboard” there is a feature where students can share their information or solve problems and share different views. It is always easy for a student to learn from other students.</p> <p><b>S4:</b> “Blackboard” simplifies my learning, am able to access learning materials, previous question papers and send or receive emails from my classmates.</p> <p><b>S5:</b> The service can be more beneficial to my learning if it is properly used by our lecturers. As students we can interact with each other, run group discussions through blackboard. The blackboard can offer me an opportunity to learn at my own pace other than at the lecturers pace. Science education is characterised by contemporary issues which as students can discuss such through blackboard.</p> <p><b>S6:</b> For the chance that I had in such a short period of time to use the blackboard helped me very much. The lecturer was able to send the learning materials, previous papers and communicate with us for any notices regarding MATE 311. Such notices include dates for writing tests and meeting for lectures.</p>	
<p><b>QS 4:</b> How does the service (“Blackboard”) benefit you as a student regarding your major subjects ( application of knowledge required)</p>	<p><b>S1:</b> Nothing special except having confidence in the course will benefit me. It makes me see the importance of ICT in this day environment of teaching and learning. Makes me realise the other options of searching for information to assist myself in my studies.</p> <p><b>S2:</b> It does not benefit me anyhow.</p> <p><b>S3:</b> The service of blackboard can help students to develop independence since every student will have their time without the teacher or lecturer. The learner/student learns to interact with the materials and information on their own. They also interpret the information on their own. It encourages collaborative learning. Learner develops computer skills, collaborative skills and communication skills.</p> <p><b>S4:</b> Access to information, communication between lecturers and peers, regular use of computer.</p>	

	<p><b>S5:</b> The service does provide with various opportunities for me to interact with aspects of contemporary issues arising out of the subject matter. Information through blackboard can be easily updated. The service gives me the idea of communicating with my lecturers without going into their offices. ICT is time saving with respect to my studies as well as being attached to the world.</p> <p><b>S6:</b> Currently I am benefiting nothing as a student regarding my major subjects from the service “Blackboard”. Reason being that I have no access to it and no one is bothering to ensure that we get access to it.</p>	
<b>PART C – ICTs BACKGROUND AND KNOWLEDGE</b>		
<p><b>QS 5:</b> How do you incorporate ICT's in your (Maths/Science/Tec hnology) curriculum studies and what challenges do you face in doing so?</p>	<p><b>S1:</b> After every lecture or when given like assignment I use ICT tools to complete my work. First one has to understand how theses ICT tools operate in order to use them. Sometimes we struggle with how the tool is functioning rather the work to be done and sometimes it is a challenge making the work you are doing to be usable in ICT. For example typing an equation into an excel software.</p> <p><b>S2:</b> it helps me to gather more information when doing my work but the challenges that I am facing is that some of the information you get is not true or is just unreliable. The information you get when using ICT you must not take it as raw as it is. You must maybe use different sources to ge the right answers.</p> <p><b>S3:</b> I will/can use the resources that will enhance the learning of mathematics in or out of the classroom. Example the projector can be used to present the information in different ways. For learner who prefer / who learn visually can learn effectively. If there is a sound those who learn auditorily will learn effectively and those who learn kinaesthetically will see animation on the projector and all different of learners will be catered.</p> <p><b>S4:</b> ICT are very significant in field of study that am currently doing. We use ICT almost every day, anywhere searching for information, typing assignments and submission of test.</p> <p><b>S5:</b> I mostly use my cellphone to explore the power of using ICT devices to gain knowledge and necessary information. The challenges that I face in doing so are that the use of in the classrooms are prohibited probably due to an assumption cellphones are used to send messages and do phone calls.</p> <p><b>S6:</b> When writing a research proposal, I sue internet service to search for relevant information which may help me to write my proposal. Currently I am writing a research report and I use the internet service to search for how do we structure or write a research report. And when I experience the problem of not having enough time to read textbooks, I consult internet because it is quick.</p>	
<p><b>QS 6:</b> Describe the benefits of incorporating ICTs'in your curriculum (Maths/Science/Tec hnology) studies?</p>	<p><b>S1:</b> It is always easy to obtain information. It gives one chance to use different method of studying. It allows teachers or lecturers to use many different method in teaching. Students do not stop learning after class.</p> <p><b>S2:</b> With ICTs you can get more information from different sources unlike reading a book written by maybe three authors meaning that the information you get is from three people , but with ICT you get information from different people with different experiences.</p> <p><b>S3:</b> It makes it easy or possible to cater for all different learners in the same time or lesson. It makes learning mathematics to be fast. Eg. Computer software are working very fast and advanced calculators can do complex calculations and different mathematical</p>	

	<p>representations.</p> <p><b>S4:</b> Incorporating ICTs in the curriculum helps us as students develop good computer skills that we are going to use for the rest of our career path.</p> <p><b>S5:</b> ICTs can be seen as an important motivational tool and enhance productivity in our curriculum. ICTs can expand access to education, thus achieving authentic goals. It enable us to take learning away from school and into the world.</p> <p><b>S6:</b> The benefits of incorporating ICTs in my curriculum studies include keeping me to date regarding advancements of technology. It makes the work easier and manageable and safe.</p>	
<p><b>QS 7:</b> How do you use ICTs to obtain curriculum resources for Maths/Science/Technology</p>	<p><b>S1:</b> Browsing the internet to access extra supporting information in my studies. Watching video tapes related to what I am doing in my studies. Use tutorial software to practice what I am currently studying.</p> <p><b>S2:</b> I only use computers to surf the net and look/search for information regarding the course that I'm studying.</p> <p><b>S3:</b> The computer hardware make it easy to obtain curriculum resources through downloading different software that can be useful in the curriculum. The computer system can be used to design tutorials and practice exercises for learners.</p> <p><b>S4:</b> I use ICT to obtain notes for mathematics and physical science from the internet.</p> <p><b>S5:</b> One of the powerful ICT device is a cellphone which we can use to download related resources like textbooks and activity sheets. ICTs are flexible to support a wide range of learning activities. The use of ICT can supplement and add up to the content we are taught in the classroom.</p> <p><b>S6:</b> by using the internet service to search for information.</p>	
<p><b>QS 8:</b> Sharing knowledge and experience with colleagues in a discussion forum/group on the internet is a way of team building. Explain how this influences the progress of your maths/science/technology studies?</p>	<p><b>S1:</b> Expands my knowledge in the subject. Expose you to different methods of reading and teaching. Improve your performance and understanding in the subject. Different techniques are explored during these discussion groups.</p> <p><b>S2:</b> I don't have a discussion forum/group on the internet which I discuss with regarding my studies.</p> <p><b>S3:</b> The discussion help in building mathematical knowledge. In discussions anyone come with his or her ideas and other come with wrong ideas. But through these discussions you can get clarity and additional information and also they can refer you to other webnotes where you can acquire numerous information which will enhance your maths.</p> <p><b>S4:</b> Sharing knowledge and experience via group forum improves my interpersonal relationships with colleagues and am able to learn some new things through my colleagues via group forum discussion.</p> <p><b>S5:</b> Collaboration plays a significant role in my studies. Collaboration influence my progress of science rapidly. There is a great power in sharing knowledge. Discussion forum enhances our conceptual understanding of science . through ICT we can use our brains effectively and logically. With ICT services, we can be more attached with our world.</p> <p><b>S6:</b> Regrettably, I have never being in any form of discussion forum/group on the internet.</p>	

<p><b>QS 9:</b> Describe how you use ICTs to enhance your innovation and creativity.</p>	<p><b>S1:</b> Some software makes you curious and hence become innovative and creative in your studies, such as <b>maple</b> (mathematics software for graph plotting).</p> <p><b>S2:</b> No response</p> <p><b>S3:</b> ICT have various resources that can help to enhance innovation and creativity. There are different resources or software that can be used to develop numerous mathematical representations for the same information.</p> <p><b>S4:</b> I use computers to store my information (notes) and to type some assignments or tasks. Notes that are stored in 'blackboard' are easily accessible by every one using "blackboard" and not easy to lose.</p> <p><b>S5:</b> The benefits of integrating information and communications technology into education are integral to the changes taking place around us. This offers us opportunity to access my innovation and creative use. Designing problems and debate questions through ICT. ICT enhance my ability to think, to learn, to communicate.</p> <p><b>S6:</b> by obtaining enough proper information online from internet and striving to acquire its meaning or making sense of it helps me to easily become innovative and creative in my assignments.</p>	
<p><b>QS 10:</b> Explain how your ICT use incorporate real-world settings and application in learning.</p>	<p><b>S1:</b> Use cellphones to access internet in learning is an example of how ICT use incorporate real-world setting in teaching and learning.</p> <p><b>S2:</b> No response.</p> <p><b>S3:</b> ICT resources can be utilised in incorporating real-world setting and application of learning. There are software which can convert world features into a mathematical representation. This can depict to learners that mathematics does not only exist in the classroom but it is also applied outside the classroom.</p> <p><b>S4:</b> In real-world setting, schools for an example, ICT is used in daily basis to communicate, deliver lesson, print and copy papers. Therefore, ICT is very significant in the learning process.</p> <p><b>S5:</b> Learning is about being able to take to the real-world what you have learned in your classroom. The scientific knowledge we learn through ICT helps us to provide solution to the real-world. As much as the world is advancing, so is ICT. The science we learn is more of society-applicable.</p> <p><b>S6:</b> By means of communicating with fellows students using mobile devices such as cell phones and using the computer to complete academic tasks. This allows one to be prepared for the emerging context of technology in the world.</p>	
<p><b>QS 11:</b> Discuss how you use ICT to promote personal and academic growth.</p>	<p><b>S1:</b> In today's world we cannot afford to ignore ICT. ICT tools are used to access information, so with ICT you can always update yourself with information related to field you are in. Well informed and up to date, man will always not have too much problem.</p> <p><b>S2:</b> I use ICT to chat with my friends via Facebook, surf the net for academic and personal information and I also use it e-mail my work amongst learners and students.</p> <p><b>S3:</b> Students can use ICT in promoting different aspects of their lives. Internet is the most resource that help students with information for both personal and subjects. Learners can solve or encounter different problems in the internet which will help in understanding the subject.</p> <p><b>S4:</b> With ICT am able to set a question paper, type it and print it, unlike when there was no ICT involved. Understanding the use of IC</p>	

	<p>is very important for us as educators. One of the roles of an educator is life-long learning and ICTs make this possible.</p> <p><b>S5:</b> ICT exposes me to the core insight of my personal and academic growth. Learning is more exciting when fun is incorporated and the use of ICT provide such fun in the route of learning and growing.</p> <p><b>S6:</b> By communicating with my fellow students and sharing academic materials via e-mail through internet service build or promote in me a sense of socializing and sharing. Academically, it helps me to learn about academic writings.</p>	
<b>QS 12:</b> Discuss how you incorporate the following in your learning programme (Math/science/Technology)		
<i>(i): Equipment and hands-on materials (projectors, internet &amp; others)</i>	<p><b>S1:</b> Internet is used to access information that one can use to comprehend the information he has in the subject. The projector can be used by lecturers and teachers to deliver teaching or lecture.</p> <p><b>S2:</b> I only use the internet for searching information. I have never used the projector.</p> <p><b>S3:</b> Information can be presented using overhead projector so that while the teacher is explaining what is on the projector, learners will be watching. The internet can be used for addition of information.</p> <p><b>S4:</b> Projectors were used to deliver lesson and the internet also for some learning material or resources.</p> <p><b>S5:</b> Projectors can be used purposefully for display images/pictures related to the topic under discussion. This can be done through teaching via multimedia.</p> <p><b>S6:</b> During presentation I used projector and the laptop and sometimes the lecturer request us to bring the laptops into the lecture session so that we can access information that will help us have a better sense of what we are learning about easily.</p>	
<i>(ii): Tutorial software</i>	<p><b>S1:</b> Tutorial software such as maple can be used by learners or students to draw graphs and work out calculations.</p> <p><b>S2:</b> I don't use it.</p> <p><b>S3:</b> The teacher can develop tutorials or make sure that every learner has access to the tutorial software so that students can solve problems irrespective of the place they are situated.</p> <p><b>S4:</b> No tutorial software used.</p> <p><b>S5:</b> Tutorial software can be incorporated in a learning programme through accessing tutorials via the software.</p> <p><b>S6:</b> Unfortunately, I have no idea of tutorial software.</p>	
	<p><b>S1:</b> E-mail and chat room networks can be used by both the lecturer and students to exchange information; it might be through discussion groups in case of the students and feedback or sending tasks to students by the lecturer.</p> <p><b>S2:</b> I use e-mail to send and receive notes from my classmates and sometimes I submit my assignment via e-mail to my technology lecturer.</p>	

<p><b>(iii):</b> Communication software (email, chat, discussion forum)</p>	<p><b>S3:</b> Communication software can help learners to discuss and work 'in team' towards their academic excellence. The teacher can group learners and recommend that all students should discuss a problem through this communication software.</p> <p><b>S4:</b> GroupWise was used for good communication between university lecturers and students via the net, then "blackboard" was introduced which is more effective than "GroupWise" because now students can also engage themselves in group discussion.</p> <p><b>S5:</b> Discussion forum can be incorporated in a learning programme by designing and creating discussion forum on the internet and as well as chat forum.</p> <p><b>S6:</b> E-mail is amongst some of the communication tools that I use to communicate with my fellow students about academic work and group meeting sessions.</p>	
<p><b>(iv):</b>Digital resources (portal, dictionaries, encyclopaedias)</p>	<p><b>S1:</b> Dictionaries and encyclopaedias can be used to check the exact meaning of the concept discussed in class.</p> <p><b>S2:</b> I used dictionary to check for the words that I don't understand.</p> <p><b>S3:</b> Planning the lesson that will need students to make use of the digital resources. Learners can also be taught how to interact with these resources so that they can use them effectively.</p> <p><b>S4:</b> No digital resources being used.</p> <p><b>S5:</b> Digital resources make learning to be more fun. Digital resources i.e. portal, dictionaries make it faster for us to browse information as compared to normal dictionaries.</p> <p><b>S6:</b> I use Cambridge dictionary to search for meaning of words and enjoy it because it is user friendly and Encarta 2008 to search information and write my assignments.</p>	
<p><b>(v):</b> Mobile devices (cell phones, iPods, etc.)</p>	<p><b>S1:</b> Cell phones and iPods can be used to access internet, dictionaries and encyclopaedias during the lecture or the lesson to get extra information about the concept or meaning of the concept.</p> <p><b>S2:</b> I also use cell phone to surf the net and search for information.</p> <p><b>S3:</b> Mobile devices can help the teacher to communicate with learners at any time and learners can be given problems for mathematics and also learners can talk about mats using them everywhere.</p> <p><b>S4:</b> For communication purposes only. E.g. calling colleagues for group meetings or discussion and study group meetings.</p> <p><b>S5:</b> The use of cell phones can be beneficial with respect to animation of the concept under study. Cell phones can be used to aid with clear pictorial presentation of the topic concepts. Video clips can also be accessed.</p> <p><b>S6:</b> Cell phone is the one that I mostly use to communicate with my group mates about meetings and sending messages.</p>	
<p><b>(vi):</b> Learning Management system ("Blackboard")</p>	<p><b>S1:</b> "Blackboard" can be used to deliver lectures or teaching which simplify the lesson in case where one deals with calculations in case of mathematics and physical sciences.</p> <p><b>S2:</b> I don't use it.</p> <p><b>S3:</b> I can use "blackboard" to communicate with learners concerning the subject and give learners necessary materials and websites to</p>	

	<p>help them with tutorials. Learners can also discuss maths using the “blackboard”.</p> <p><b>S4:</b> For communication (online) between lecturer – student and student – student. Delivery of tasks given by lecturer and interaction with other.</p> <p><b>S5:</b> “blackboard” can be incorporated in such a way that learners receive module materials through the system and also debate scientific issues with their peers across the system through group forums. Learners can also submit their assignments online.</p> <p><b>S6:</b> Lamentably, I no longer have access to “blackboard” i.e. I’m not using it.</p>	
<p><b>QS 13:</b> How do you use the internet (select suitable websites, user groups, discussion forum) to support your learning (Mathematics/Science/Technology)?</p>	<p><b>S1:</b> In case where inquiry-base learning is used as a method of teaching, the educator can give the student a certain investigation and give specific websites and discussion forum to access information and do the investigation to assist them in doing the investigation.</p> <p><b>S2:</b> I use the internet to search information regarding my studies.</p> <p><b>S3:</b> Internet contains different websites with mathematics tutorials which can help students to learn maths effectively. Some websites have animation on solving different problems on maths. A student will watch how problems are solved with different steps involved.</p> <p><b>S4:</b> I used the internet to obtain notes and other resources from websites such as tutong.gov, science and mathematics websites.</p> <p><b>S5:</b> Instructional materials must include related websites where learners can actually access additional, relevant information. Computer labs or classes can be used as a source of learners accessing additional sources or relevant information with regards to science aspects. Internet can be beneficial if it is profitably used. I use internet to access simplified version of topics under discussion.</p> <p><b>S6:</b> I select websites depending on how fast does it take to open a page and how often does it give me problems. For an example, currently I am using Google Chrome because it is convenient for me unlike internet explorer.</p>	
<p><b>QS 14:</b> Discuss how you use ICTs for lifelong oriented skill development?</p>	<p><b>S1:</b> The ICT to make learning very interesting and look easy, so students will always be curios, they will try to do work done in class. Hence continue building on the work they know about particular subject.</p> <p><b>S2:</b> No response</p> <p><b>S3:</b> By acquiring valuable and essential information from the internet every time and using various equipment to deliver the lesson.</p> <p><b>S4:</b> ICT provides me with an opportunity to practice some basic skills (such as learning how to solve an equation or how to react different compounds) on my own time and on my own pace.</p> <p><b>S5:</b> ICT is beneficial with respect to assisting me with the skills of searching and analysing information with regard to being a scholar. Being a scholar requires lifelong skills of accessing relevant information and assistance through ICT services.</p> <p><b>S6:</b> The more time I have to be on the computer I learn about a lot of things, like how to deal with dysfunctional software program, what commonly slows down the performance of the computer.</p>	
	<p><b>S1:</b> Use of tutorial software to test your knowledge in the subject and use of e-mail to exchange information with your lecture this includes</p>	

<p><b>QS 15:</b> One of the traditional importance of ICTs is using it to conceptualise learning materials, complete exercises, assess your progress and feedback from lecturers. Explain how you use ICTs for the above and monitor your progress?</p>	<p>receiving assignments, feedbacks and also asking questions where you encounter problems within the learning area.</p> <p><b>S2:</b> No response</p> <p><b>S3:</b> After every lesson, I would visit different websites on the internet to check for additional information concerning the subject matter and also visit tutorials websites in order to extend on what the teacher or the lecturer have done in class. Tutorials will help me to monitor my progress and also check where I'm lacking and need to improve.</p> <p><b>S4:</b> During my study here at the university of Limpopo, ICT was used to complete exercises, search for information, and submission of assessment tasks, feedback from lecturers and also for presentation.</p> <p><b>S5:</b> Conceptualising learning materials is more of incorporating animation and video clips with regards to enhancing learners' conceptual understanding. Access animation and also video clips of explaining concepts help me to conceptualise concepts.</p> <p><b>S6:</b> Honestly, I haven't been in any situation of conceptualising learning materials, completing exercises, assessing my progress and receiving feedback from my lecturers through the use of ICT before.</p>	
<p><b>QS 16:</b> How do you use ICT in collaborative and cooperative learning in Maths/Science/Technology?</p>	<p><b>S1:</b> When giving learners activities such as investigation, you will always encourage learners to use other form of searching additional information that will assist them in getting the required solution for the investigation. These forms of searching for information include internet.</p> <p><b>S2:</b> No response.</p> <p><b>S3:</b> ICT have many websites and software that allow learners to communicate. Learners can be given topic or problems to discuss. If they are away from one another ICT can play a big role in helping them to finish the work.</p> <p><b>S4:</b> ICT supply students with a platform through which they can communicate with colleagues from distance places any time, exchange work or ideas, and offers the most effective means for bringing students together in learning (foster cooperative learning).</p> <p><b>S5:</b> ICT devices can be used to ignite interest with respect to engaging and interacting with my peers. Learning and discussing through group forums/discussions brings the joy of learning. Science education requires us to share ideas and debate contemporary issues arising. The use of MixiT or whatsapp can be used as part of incorporating group discussions.</p> <p><b>S6:</b> I use it to see different solutions or answers provided to same question or problem by different people on the internet, and then I use my interpretation or comprehension of those solutions or answers to lead group discussions during group meetings.</p>	
<p><b>QS 17:</b> Explain how you use ICTs to facilitate lifelong learning</p>	<p><b>S1:</b> Always when trying to understand particular concepts, ICTs are used as an option in assisting you to understand that concept by browsing the internet to get additional information that can explain to you the concept from different angles.</p> <p><b>S2:</b> No response.</p> <p><b>S3:</b> With ICT, learners' have an access to most information all over the world. I can encourage learner to always interact with ICT resources like internet and tutorial software in order for them to improve and learn, discover new things every day.</p> <p><b>S4:</b> ICT foster inquiry and exploration, it opens the whole world of</p>	

	<p>lifelong, upgrading and professional development for me. Fast changing technology-based on economy requires students' flexibility to adjust to new demands and the ability to learn new skills, and ICT provide me with an opportunity to do this.</p> <p><b>S5:</b> Facilitating lifelong learning is an important aspect. ICT can be used to facilitate such aspect through the use of related video clips of the content and as well as using it to access, search and analyse information. The use of internet is very crucial with respect to lifelong learning. ICT provide us with wider space of learning.</p> <p><b>S6:</b> By reading current news online about my profession and pursuing work out emerging problems or questions on internet regarding mathematics for education.</p>	
<p><b>QS 18:</b> Discuss how you use ICTs to increase learning motivation and making learning more of fun and interesting and individualise your learning experiences to address learning needs?</p>	<p><b>S1:</b> The world of information and communications technology is always interesting and challenging. If you can overcome those challenges you will always want to learn more things about ICT tools. When ICT is incorporated with teaching and learning, as students we will always be motivated and interested in learning.</p> <p><b>S2:</b> No response</p> <p><b>S3:</b> By creating groups on the internet, especially Facebook and Gmail's so that we can as groups discuss aspects concerning education, subjects and social issues. We can post different problems and topics that can be discussed each day. This will influence our learning and motivation in an effective manner. Those who don't study will get motivated to study in order to conform to the groups.</p> <p><b>S4:</b> ICT allows for increased accessibility to the information relevant to the course and enhance student interaction outside class. ICT improved my ability to archive and retrieve my work and provide an increased structuring of information. ICT is fun and interesting to apply in learning because it provides diverse sources of information.</p> <p><b>S5:</b> The level of motivation is actually aroused when we see the things we are learning about. ICT can be used as it provides all the various pictorial and video clips which make learning more fun. Discussions become more motivated-centred as we "see" visual presentations which provide insight and direction on our learning. ICT incorporation in learning environment caters all various learning styles in the classroom when all learners are accommodated learning becomes interesting and individual learning experiences are developed.</p> <p><b>S6:</b> By using the laptop and the projector to project the lesson and sometimes instead of teaching I use video lesson in which learners watch the video. As they watch the video, I pause it at times to allow questions which may be from an individual and some of the questions may be answered by playing back the video.</p>	

## APPENDIX C

### RESEARCH QUESTIONNAIRE - LECTURERS

Date: \_\_\_\_\_ CODE: QL 01/02/03/04/05/06/07/08

Email: \_\_\_\_\_ Phone No: \_\_\_\_\_

#### INTRODUCTION

This is a PhD research questionnaire which aims at investigating the pedagogical integration of Information Communication Technologies (ICT) in Initial Teacher Education (ITE) The purpose of the questionnaire is to determine how the ICT pedagogy of lecturers and students of mathematics, science and technology education influences the process of constructing knowledge and conceptual understanding. Kindly be as open and free as possible. Be assured that absolute confidentiality will be adhered to and under no circumstance will your detail information and any part of your response be divulged to a third party.

#### INSTRUCTION

Kindly respond to all the questions to the best of your ability. Your honesty will be deeply appreciated. Express yourself as much as you wish. The questions have been framed with care and consideration. However, if clarity on any aspect/issue is required, the researcher will be very willing to provide such assistance at any time. A follow-up interview (verbatim) will be organised by the researcher to address issues that may arise from the questionnaire.

#### RESPONDENT DATA - LECTURERS

QS (a) Kindly talk briefly about yourself. (Name, Age and Date of Birth may be ignored)

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QS (b) What is your highest academic and /or professional qualification?

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QS (c) How long have you been lecturing in this institution?

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QS (d) What subject(s) do you lecture for the past three academic years?

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QS (e) Briefly describe your experience lecturing these (this) subject(s).

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QS (f) Describe your experience of any kind of internship / practical teaching / field work supervision.

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QS (g) Briefly share your dream for your section in the institution.

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**RESEARCH QUESTIONS**

QL1. Kindly tell me about your experience with ICT's

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QL2. The university has introduced the "Blackboard" service which is an ICT initiative. Workshops and courses were organised at different phases for both lectures and students. What is your take and experience of this service?

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QL3. How does the service ("Blackboard") influence your teaching?

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QL4. How does the services ("Blackboard") benefit you and your students (application of knowledge acquired)?

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*Let's move on to your personal use of ICTs' to advance teaching and learning for conceptual understanding, innovation and creativity and skill development of your students.*

QL5. How do you incorporate ICTs' in your (Maths/Science/Technology) curriculum delivery and what challenges do you face in doing so?

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QL6. Discuss the benefits of incorporating ICTs' in your curriculum (Maths/Science/Technology) delivery?

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QL7. How do you use ICTs to obtain curriculum resources?

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QL8. Sharing knowledge and experience with colleagues in a discussion forum/group on the internet is a way of team building. Explain how this influences the progress of your curriculum delivery?

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QL9. Describe how you use ICT to enhance your students' innovation and creativity

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QL10. Explain how your ICT use incorporate real-world settings and application for student learning?

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QL11. Discuss how you use ICT to promote personal and professional growth?

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QL12. Discuss how you incorporate the following in your students' learning programme.

(i) Equipments and hands-on materials (projectors, internet, others).

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(ii) Tutorial software.

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(iii) Communication software (email, chat, discussion forum)

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(iv) Digital resources (portal, dictionaries, encyclopaedias)

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(v) Mobile devices (cell phone, iPods, etc.)

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(vi) Learning management systems ("Blackboard")

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QL13. How do you assist students to use the internet (select suitable websites, user groups, discussion forum) to support their learning?

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QL14. Discuss how you use ICTs to provide effective, efficient and dynamic service which is student skill development oriented?

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QL15. One of the traditional importance ICTs in your practice the use in presenting information, give class instruction, assess students' progress and give feedback to students. Explain how you skill students to use ICTs to obtain feedback and monitor their progress?

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QL16. How do you skill students' to use ICTs in collaborative and cooperative learning in maths/science/technology?

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QL17. How do you prepare lessons that involve the use of ICTs by students?

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QL18. Explain how you use ICTs in your practice to facilitate students' lifelong learning?

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QL19. Discuss how you use ICTs to prepare students for the world of work, provide opportunities for them to learn from peers/experts, increase learning motivation and making learning more of fun and interesting, competent ICT use, responsible internet behaviour and individualise their learning experiences to address learning needs?

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**End of questionnaire.** Thanks very much for taking time off your busy schedule to respond to my request

## APPENDIX D

### LECTURERS DATA – QUESTIONNAIRE

QUESTIONS	RESPONSES	COMMENT
<b>PART A – PERSONAL INFORMATION</b>		
<p><b>QL (a):</b> Kindly talk briefly about yourself (name, age and date of birth may be ignored)</p>	<p><b>L1:</b> I am a family woman who is passionate about teaching. I like teaching Physics very much. Imparting knowledge of things that happen in real-life makes me go “wow” because as I explain some of these phenomenon, students eyes look like they will ‘pop out’, others with smiling faces while others wonder if that is possible; it is very interesting . I like it when they ask questions about Physics related phenomenon.</p> <p><b>L2:</b> I am a lecturer at the [REDACTED] [REDACTED] I started working in the university from 1<sup>st</sup> July 2012 to date. I am lecturing methods subjects and content in years 3 and 4. My line of specialization is in Technology education.</p> <p><b>L3:</b> I am a 51 year old Indian male that works at the [REDACTED] as a lecturer for method of Physical Science. I also co-ordinate the Bed undergraduate modules in the programme and lecture to and supervise post-graduate students.</p> <p><b>L4:</b> I am committed to advance technology education in such a way that students fully understand its purpose and be able to implement it in their respective schools. Always seeking for new information that could better my research of teaching approach. I remain open-minded to new new developments in this field.</p>	
<p><b>QL (b):</b> What is your highest academic and / or professional qualification?</p>	<p><b>L1:</b> BSc. (Ed); BSc. (Hons); Busy with Masters</p> <p><b>L2:</b> MEd</p> <p><b>L3:</b> D. Ed</p> <p><b>L4:</b> Doctor of Education ( Education Management)</p>	
<p><b>QL (c):</b> How long have you been lecturing in this institution?</p>	<p><b>L1:</b> 3years</p> <p><b>L2:</b> Since July 2009 to date</p> <p><b>L3:</b> From 2006, 6 years</p> <p><b>L4:</b> 4 years</p>	
<p><b>QL (d):</b> What subject(s) do you lecture for the past three academic years?</p>	<p><b>L1:</b> Physics for BSc. extended degree programme (BSc. EDP); A course or two in Physical Science for educators (Physics section)</p> <p><b>L2:</b> Method technology for Educators 3 &amp; 4;</p>	

	<p>Technology for Educators 4</p> <p><b>L3:</b> Method of Physical Science; Physical Science for educators</p> <p><b>L4:</b> Technology Education 1 &amp; 3 including Hons</p>	
<p><b>QL (e):</b> Briefly describe your experience lecturing this (these) subject(s).</p>	<p><b>L1:</b> BSc. EDP is some kind of a “bridging” course thus there are challenges in the sense that misconceptions are cleared and introducing students to varsity courses, laboratories and equipment it’s a ‘wow’ to a lot of them. In physics for educators, their course work-content is large and sometimes difficult to complete because students have to go for practice teaching.</p> <p><b>L2:</b> My experience with the subject is that they are quite a challenge to students since Technology has never been part of FET main stream subjects. Most students are from Mathematics &amp; Physical Sciences background. However efforts are put in place to make sure that at the end we produce capable and knowledgeable teaching force to teach the subject.</p> <p><b>L3:</b> My initial experience was challenging as I came from a school to university. Also, at the beginning there were no mentors or course materials to follow. This meant that I had to design materials from just a course outline. Now, lecturing is very fulfilling / rewarding.</p> <p><b>L4:</b> It is important to research on the best practice(s) and continue to learn about new instructional strategies &amp; there is a lot to be done since the subject is relatively new in SA</p>	
<p><b>QL (f):</b> Describe your experience of any kind of internship/practical teaching/fieldwork supervision.</p>	<p><b>L1:</b> N/A – I do not have experience on the above.</p> <p><b>L2:</b> It is a challenge in that one had to be all out there to help the students since teachers (practioners) are not that familiar with the subject to assist student teachers during practice teaching. Bored on supervision, it is a challenge since there are few scholars in the field and less research done on the subject (Technology) so it is becoming difficult for students to find relevant literature.</p> <p><b>L3:</b> I was a teacher for 24 years before joining the university. I currently supervise honours, masters and Ph. D. students.</p> <p><b>L4:</b> Not convinced that we are doing justice to appropriate teacher training. Students are not fully trained on how to implement CAPS. The main aims of the curriculum are compromised – e.g. critical thinking skills are not encouraged by respective academics.</p>	

<p><b>QL (g):</b> Briefly share your dream for your section in the institution.</p>	<p><b>L1:</b> I wish to produce graduates that are:</p> <ul style="list-style-type: none"> <li>- Well-equipped and confident in teaching Physics and contribute positively to the community they will be serving.</li> <li>- Technology literate so that they can fit well in the 21<sup>st</sup> century</li> <li>- Knowledgeable, have skills and is diligent and be able to transfer what they have learned.</li> </ul> <p><b>L2:</b> my dream is that Technology need to be grown up to a level where we produce teachers who can teach in main stream schools and FET colleges who will have enough skills to handle technology &amp; Technical subjects.</p> <p><b>L3:</b> There is a critical need for Physical science / Maths teachers in our country. I believe that we are ideally placed, as s university, to address the challenge. My dream is that we would increase our intake of students so that we can meet the needs of the province / country without compromising on the quality of teachers produced.</p> <p><b>L4:</b> Intend to create a formidable technology education hub with sufficient pool of post graduate students. Our students, particularly undergraduates should develop authentic solutions.</p>	
<b>PART B – ICT BACKGROUD INFORMATION</b>		
<p><b>QL 1:</b> Kindly tell me about your experience with ICT's</p>	<p><b>L1:</b> ICTs; supportive in computer related issues and ensures the smooth running thereof.</p> <p><b>L2:</b> My experience with ICT is limited to the use of computer &amp; internet to develop and access course materials and relevant journal articles for my subject.</p> <p><b>L3:</b> I am a computer literate without attending a computer course. Technically I am self-taught. I enjoy using technology to enhance lessons. I have been using a computer for the past 20 years or more.</p> <p><b>L4:</b> In the first world communities, it is realistic. I fully support it, but not yet ready to implement it in my subject(s). a lot still need to be done.</p>	
<p><b>QL 2:</b> The university has introduced the "Blackboard" service which is an ICT initiative. Workshops and courses were organised at different phases for both lecturers and students. What is your take</p>	<p><b>L1:</b> "Blackboard" is a good tool for all stakeholders.</p> <ul style="list-style-type: none"> <li>- It makes lecturing easy</li> <li>- It makes marking – multiple choice questions easy.</li> <li>- It makes accessing lecture notes etc. easy and reduces paper work</li> <li>- It make communicating with students easy.</li> </ul>	

<p>and experience of this service?</p>	<p><b>L2:</b> There was a good initiative in that it gave an insight on how to engage your material with students on line. However, the initiative is not an earn one as it needs some refresher course every now and then. Secondly, the lecture halls do no promote the use of such initiative.</p> <p><b>L3:</b> I was trained on “Blackboard” together with colleagues in the school. A person from the company (“Blackboard”) provided the training. Thereafter, the university’s IT department provided follow-up training for lecturers. The follow-up training was open to all lecturers. I believe that some of our new lecturers need to be trained on Blackboard. The service offered on the campus is satisfactory.</p> <p><b>L4:</b> The service is good but our students still prefer contact sessions with lecturers.</p>	
<p><b>QL 3:</b> How does the service (Blackboard) influence your teaching?</p>	<p><b>L1:</b> It makes lecturing easy because materials – lecture notes, tutorials etc. can be easily accessed by students.</p> <ul style="list-style-type: none"> <li>- It encourages students to search for more information.</li> <li>- Students can consult on-line</li> <li>- I can interact with students using text messages.</li> <li>- In case I forgot to mention something in a lecture, I can paste it on the blackboard.</li> <li>- In case a student is absent, (s)he can access the information from wherever (s)he is</li> </ul> <p><b>L2:</b> The influence it has on my teaching is that am able to communicate the latest information with my students some of which might not be part of their module material or study material. It saves time and paper. They (students) are able to download the information in their own time, but too many students less resources such as computer access.</p> <p><b>L3:</b> “Blackboard” enables a variety of resources to be made accessible to students. Using Blackboard, students can be exposed to e-books, videos, and participate in discussion forums. Using Blackboard, forum is environmentally friendly as lots of materials do not have to be printed. Students can read information online. “Blackboard” also allow learners to get immediate feedback from assessment. Through “Blackboard” the student is always in contact with me and other classmates. The module is not restricted just to the class.</p> <p><b>L4:</b> Not at all (<i>see reason in interview transcript</i>)</p>	
	<p><b>L1:</b> - On-line filing</p> <ul style="list-style-type: none"> <li>- Communication with students</li> <li>- Interacting with students</li> <li>- Consultation can be done online</li> </ul>	

<p><b>QL 4:</b> How does the service (“Blackboard”) benefit you and your students (application of knowledge acquired)?</p>	<ul style="list-style-type: none"> <li>- Monitor the number and name of students who went through the material</li> <li>- Once the material is pasted on the “Blackboard” it can be revised</li> <li>- Marking is made easy – multiple choice questions</li> </ul> <p><b>L2:</b> I have never tried this one yet, but some of my response in QL 3 still apply here;</p> <p><b>L3:</b> “Blackboard” enables students to be exposed to additional materials that will enhance their understanding. If the student had a better understanding of the contents, the student will not have difficulty to apply what was learnt. “Blackboard” also allows multimedia to be uploaded which is beneficial for students.</p> <p><b>L4:</b> No (<i>ref: interview transcript for reasons</i>)</p>	
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**PART C – ICTs KNOWLEDGE AND USAGE**

<p><b>QL 5:</b> How do you incorporate ICT's in your (Maths/Science/Technology) curriculum delivery and what challenges do you face in doing so?</p>	<p><b>L1:</b> Incorporating ICTs;</p> <ul style="list-style-type: none"> <li>- I paste lecture notes, tutorials, practical preview etc, on “Blackboard”.</li> <li>- Make any other information available to students by pasting it on “Blackboard”.</li> <li>- The advantage is that, one can restrict information availability to a special time interval.</li> </ul> <p>Challenges;</p> <ul style="list-style-type: none"> <li>- To access the information e.g. when writing an exercise, test, etc. students have to have a password they may give this to someone who is not in the computer lab.</li> <li>- Once the stipulated time for the exercise is over, it cannot be reassessed / reopened.</li> <li>- Only multiple choice questions are ideal, for long questions, it is not ideal as it will require students to type and most of our students are not computer literates.</li> </ul> <p><b>L2:</b> By referring students to access information from internet. This is done after identifying websites. The students use these websites to write some assignment which requires information from the websites. The challenge is time frame and access to computers for those who cannot afford buying their own laptops.</p> <p><b>L3:</b> The university has Wi-Fi connections in our block. I am able to access the internet in my class. Sometimes, lessons are conducted by accessing specific information on certain websites. Also, lessons are presented using a data projector. This ensures that the lesson is virtual and interesting for learners. Sometimes videos are taken of presentations done by</p>	
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	<p>students and this is viewed later for discussion by all students – allowing students to learn from practice.</p> <p><b>L4:</b> Did not (<i>ref interview transcript</i>)</p>	
<p><b>QL 6:</b> Discuss the benefits of incorporating ICTs in your curriculum (Maths/Science/Technology) delivery?</p>	<p><b>L1:</b> - Information is easily accessible by students</p> <ul style="list-style-type: none"> <li>- It teaches them time management because information will be available for specific time interval (in some instances)</li> <li>- Marking (multiple choice questions) is made easy.</li> <li>- I use online filling for future use – no paper work</li> <li>- Students are easily reachable</li> <li>- I can supervise / monitor students' access materials on "Blackboard" through "Grade centre".</li> </ul> <p><b>L2:</b> It enforces students to get used to computers and searching information related from the internet and learns to access journal articles.</p> <p><b>L3:</b> ICT ensures that information is not just black and white (printed form only)</p> <ul style="list-style-type: none"> <li>- ICT ensures that we are able to tap into the digital world and enable students to access information in a variety of ways.</li> <li>- ICT ensures that the classroom is not restricted to the building. A student is able to access information and contact peers at any time. This changes the way you design your materials for students.</li> <li>- Social media ensures that people are always 'connected'; this can be beneficial for students if used correctly.</li> </ul> <p><b>L4:</b> I think it will encourage computer literacy and enable or foster independent research students.</p>	
<p><b>QL 7:</b> How do you use ICTs to obtain curriculum resources?</p>	<p><b>L1:</b> - I refer to the ICT library for the prescribed book and any other physics book with the topic in question.</p> <ul style="list-style-type: none"> <li>- If I find something interesting and relevant, I paste it on "Blackboard" and save it for future use.</li> </ul> <p><b>L2:</b> As outlined in QL 6 and QL 3</p> <p><b>L3:</b> I search the internet for relevant resources to use in my classes.</p> <ul style="list-style-type: none"> <li>- The internet enables me to find relevant articles to use in my classes</li> <li>- Websites like 'You Tube' enables me to access videos that I can use in my lessons.</li> <li>- ICT enables me to access a wide</li> </ul>	

	<p>range of e-books which can be used by my students.</p> <p><b>L4:</b> N/A</p>	
<p><b>QL 8:</b> Sharing knowledge and experience with colleagues in a discussion forum/group on the internet is a way of team building. Explain how this influences the progress of your curriculum delivery?</p>	<p><b>L1:</b> Discussion with colleagues is essential because I may get some information that I did not know and / or share ideas I have gained with them.</p> <p><b>L2:</b> Such forum does not exist in our department.</p> <p><b>L3:</b> - In some of the programme / modules that I lecture, I work with a colleague, we share ideas and then plan the delivery of the module</p> <ul style="list-style-type: none"> <li>- Sharing ideas with a colleague enable me to get different views on how the same content can be delivered. This influences the teaching strategies we adopt in the class.</li> </ul> <p><b>L4:</b> N/A</p>	
<p><b>QL 9:</b> Describe how you use ICTs to enhance your students' innovation and creativity.</p>	<p><b>L1:</b> - I paste interesting, life related questions on "Blackboard" for the students to respond.</p> <ul style="list-style-type: none"> <li>- The other time, I requested them to bring their laptops to class and browsed through so to see the animation of nuclear reactions.</li> <li>- They went to search for more and were able to understand how nuclear reactions take place.</li> </ul> <p><b>L2:</b> Due to lack of such facilities in our teaching venues it is difficult to say that students engagement in such enhancing their innovation and creativity except showing the few slides that I prepare for my class. In short, it is not possible at this stage. (<i>follow-up in interview transcript</i>)</p> <p><b>L3:</b> - innovation and creativity is essential for any beginning teacher.</p> <ul style="list-style-type: none"> <li>- ICT enables information to be presented in creative and innovative ways. This enables students to view this and try to present their information creatively and innovation</li> </ul> <p><b>L4:</b> Based on the training I have received it enable lecturer-student interaction. Students visit the site frequently &amp; respond.</p>	
<p><b>QL 10:</b> Explain how your ICT use incorporate real-world settings and application for student learning.</p>	<p><b>L1:</b> - IT section of the university created e-mail addresses for all the students</p> <ul style="list-style-type: none"> <li>- The computer labs are accessible for use. (<i>Interview transcript</i>)</li> </ul> <p><b>L2:</b> Ref to respond QL 9 (<i>Interview transcript</i>)</p> <p><b>L3:</b> - The use of examples from real-life makes learning relevant and interesting for students</p>	

	<ul style="list-style-type: none"> <li>- ICT enables me to find relevant practical, real-life examples to use in my classes.</li> <li>- Learning should be fun, exciting and meaningful to students. ICT enable me to have these kinds of lessons.</li> </ul> <p><b>L4:</b> No response (<i>Interview transcript</i>)</p>	
<b>QL 11:</b> Discuss how you use ICT to promote personal and professional growth.	<p><b>L1:</b> - I use it to access the internet</p> <ul style="list-style-type: none"> <li>- To research materials online</li> <li>- To research simpler ways to introduce a topic and uses in real-life situation (application in real-life)</li> <li>- To search for sub-topics that will contribute towards making teaching interesting.</li> </ul> <p><b>L2:</b> Ref to response QL 9</p> <p><b>L3:</b> - ICT enables me to access the latest research in my field</p> <ul style="list-style-type: none"> <li>- It enables me to keep in contact with colleagues, experts in my field</li> <li>- It enables me to network with peers in other countries.</li> </ul> <p><b>L4:</b> Independent research students.</p>	
<b>QL 12:</b> Discuss how you incorporate the following in your students' learning programme.		
<i>(i): Equipment and hands-on materials (projectors, internet &amp; others)</i>	<p><b>L1:</b> I use almost all methods; chalk, whiteboard, projectors, internet etc. This is to assist students to have an idea of all equipment that (s)he may come across in his/her teaching experience. Not all schools are technologically sound.</p> <p><b>L2:</b> During lectures I use projectors sometimes and identification and designing module activities that encourages them to use the internet.</p> <p><b>L3:</b> - Students are required to conduct research using the internet / library.</p> <ul style="list-style-type: none"> <li>- Students make presentations using data projectors.</li> </ul> <p><b>L4:</b> Given that we do not have (DMSTE) suitable technology education laboratory, I used to invite students in my office and we search for relevant information that enhance the understanding of a particular topic. Animations assist a lot.</p>	
<i>(ii): Tutorial software</i>	<p><b>L1:</b> - Tutorials are pasted on the "Blackboard"</p> <ul style="list-style-type: none"> <li>- In case they (students) have challenges we communicate online</li> <li>- They get the answers / memo as soon as they are done.</li> </ul> <p><b>L2:</b> Not available (<i>interview transcript</i>)</p>	

	<p><b>L3:</b> Never used this</p> <p><b>L4:</b> Not yet</p>	
<p><b>(iii):</b> Communication software (email, chat, discussion forum)</p>	<p><b>L1:</b> This is done online or by text messages</p> <p><b>L2:</b> Does not exist</p> <p><b>L3:</b> e-mail used to send students additional resources, materials and communicate module information.</p> <ul style="list-style-type: none"> <li>- I have not used discussion forums.</li> </ul> <p><b>L4:</b> Not yet</p>	
<p><b>(iv):</b>Digital resources (portal, dictionaries, encyclopaedias)</p>	<p><b>L1:</b> Do not use this very much</p> <p><b>L2:</b> Do not exist</p> <p><b>L3:</b> - These resources are used via the internet.</p> <ul style="list-style-type: none"> <li>- Students access this information to supplement the information they already have</li> </ul> <p><b>L4:</b> Not yet.</p>	
<p><b>(v):</b> Mobile devices (cell phones, iPods, etc.)</p>	<p><b>L1:</b> Students may access “Blackboard” through their cell phones</p> <p><b>L2:</b> Send ‘sms’ to advise about attendance</p> <p><b>L3:</b> - Cell phones have been used to communicate with students</p> <ul style="list-style-type: none"> <li>- In class, students have used cell phones to access the internet and search for additional information.</li> </ul> <p><b>L4:</b> Not yet.</p>	
<p><b>(vi):</b> Learning Management system (“Blackboard”)</p>	<p><b>L1:</b> No response (<i>interview transcript</i>)</p> <p><b>L2:</b> I have not utilised it</p> <p><b>L3:</b> - module materials are uploaded on “Blackboard”.</p> <ul style="list-style-type: none"> <li>- Students are able to access the information from anywhere.</li> </ul> <p><b>L4:</b> Not yet</p>	
<p><b>QL 13:</b> How do you assist students to use the internet (select suitable websites, user groups, discussion forum) to support their learning?</p>	<p><b>L1:</b> - I started by encouraging them to use the internet and showed them the positive side of using it.</p> <ul style="list-style-type: none"> <li>- I then refer them to some websites and discussed what they got in a lecture.</li> <li>- The other time I requested them to bring their laptops in class, selected websites relevant for that day’s topic.</li> </ul> <p><b>L2:</b> I identify useful sites and give them task to look for themselves.</p>	

	<p><b>L3:</b> - Students are given specific websites to access information e.g. webelements.com</p> <ul style="list-style-type: none"> <li>- Post-graduate students are given websites / databases to consult to look for relevant literature.</li> <li>- Students are also given specific websites to obtain resources to enhance their classroom practice.</li> </ul> <p><b>L4:</b> I recommend appropriate sites and encourage them to explore them in their own space.</p>	
<p><b>QL 14:</b> Discuss how you use ICTs to provide effective, efficient and dynamic service which is student skill development oriented.</p>	<p><b>L1:</b> - I requested IT to address my group on “Blackboard” and encourage them to use it. Explained the important benefits of using “Blackboard”.</p> <ul style="list-style-type: none"> <li>- In case I encounter challenges, they assist.</li> <li>- It has to facilitate computer literacy courses for students so that there are no delays starting with “Blackboard” and that we ask long questions and not restricted to multiple choice questions only.</li> </ul> <p><b>L2:</b> Non existence</p> <p><b>L3:</b> - ICT is integrated with the presentation of the module</p> <ul style="list-style-type: none"> <li>- I do not focus specifically on developing students ICT skills</li> <li>- The programme has CLIT in year 1 and 2 that focuses on the development of ICT skills.</li> </ul> <p><b>L4:</b> Not yet</p>	
<p><b>QL 15:</b> One of the traditional importance of ICTs in your practice is the use in presenting information, give class instruction, assess students’ progress and give feedback to students. Explain how you skill students to use ICTs to obtain feedback and monitor their progress?</p>	<p><b>L1:</b> - With the help of “Blackboard” I can paste any instruction / information that must reach the students; also feedback and other related stuff are accessed within a time frame. They will access this through their e-mail box.</p> <ul style="list-style-type: none"> <li>- To monitor their progress, I use grade centre which informs me about the students who went through the pasted information.</li> </ul> <p><b>L2:</b> None</p> <p><b>L3:</b> - This is an area for improvement in my teaching- the lack of use of ICT for student feedback</p> <ul style="list-style-type: none"> <li>- Due to the nature of the modules I teach, little or no use of ICT is used for feedback.</li> <li>- As mentioned in the previous question, I do not spend time teaching ICT skills to students.</li> <li>- I have not done a test on “Blackboard” where students get immediate feedback. It is something I would want to do.</li> </ul> <p><b>L4:</b> Not yet.</p>	

<p><b>QL 16:</b> How do skill students to use ICT in collaborative and cooperative learning in Maths/Science/Technology?</p>	<p><b>L1:</b> Through ICT workshops on “Blackboard” to the students</p> <p><b>L2:</b> N/A (<i>explain – ref interview transcript</i>)</p> <p><b>L3:</b> - Group work is encouraged in my modules. Students are required to access different information on a specific task e.g. a debate on the benefit/shortfalls of fracking.</p> <ul style="list-style-type: none"> <li>- By access information separately, students come together to do a presentation.</li> </ul> <p><b>L4:</b> Not yet</p>	
<p><b>QL 17:</b> How do you prepare lessons that involve the use of ICTs by students?</p>	<p><b>L1:</b> - I prepare lessons such a way that it has questions that require them to search for answers on the internet – usually a question(s) that cannot be easily found from a book.</p> <ul style="list-style-type: none"> <li>- Sometimes I use slides/points and this will prompt them to look for more information.</li> <li>- In other instances, I request them to search about a topic and discuss it in a lecture the next time we meet often in presentation form.</li> </ul> <p><b>L2:</b> Ref to QL 13 (<i>responded in interview transcript</i>)</p> <p><b>L3:</b> - These are prepared as I prepare any other lesson.</p> <ul style="list-style-type: none"> <li>- ICT is considered a resource in my lesson.</li> </ul> <p><b>L4:</b> Firstly, I look at the the topic to be presented and then browse suitable and informative site that will enhance my presentation and after classroom presentation, I invite students to my office to explore selected sites.</p>	
<p><b>QL 18:</b> Explain how you use ICTs in your practice to facilitate students life-long learning?</p>	<p><b>L1:</b> No response</p> <p><b>L2:</b> Accessing articles and journal articles local and international to develop study materials.</p> <p><b>L3:-</b> Being a teacher means a lifelong learner</p> <ul style="list-style-type: none"> <li>- In my module, learners are encouraged to keep up to date with latest developments in science e.g. SKA</li> <li>- Questions are posed to learners / students at the beginning of each lesson on latest trends / developments.</li> <li>- -what I noticed was that my students will pose questions to me about these developments.</li> <li>- By getting learners to keep up to date, I hope that this is something they will be taking into their classes and practice personally.</li> </ul> <p><b>L4:</b> We live in the age of information and the library is getting redundant, ICT will enable us to obtain information (up-to-date) anywhere,</p>	

	anytime. E-resources are becoming effective.	
<p><b>QL 19:</b> Discuss how you use ICTs to prepare students for the world of work, provide opportunities for them to learn from peers/experts, increase learning motivation and making learning more of fun and interesting, competent ICT use, responsible internet behaviour and individualise their learning experiences to address learning needs?</p>	<p><b>L1:</b> - I did this only once.</p> <ul style="list-style-type: none"> <li>- I gave subtopics to students for research purpose</li> <li>- I divided the students into groups</li> <li>- I gave the groups subtopics to go and research</li> <li>- I informed them that the response will be in a presentation form and marks will be allocated and will contribute towards their year mark.</li> <li>- One month was given for this research.</li> </ul> <p>Undertook a trip to one of the hospital to observe:</p> <ul style="list-style-type: none"> <li>- The use of lasers</li> <li>- The use of radioactivity: X-rays; chemotherapy, CT Scan. On return, students were expected to write a report of their observation (in groups).</li> </ul> <p><b>L2:</b> As mentioned in QL 12 – 16, I have not embarked on an intensive use of ICT fully to equip students for the world of work. Except accessing websites on the internet to write their assignments.</p> <p><b>L3:</b> - Students are encouraged to use ICT to access resoirces and materials that will help them as teachers</p> <ul style="list-style-type: none"> <li>- Students are encouraged to purchase laptop to use as teachers</li> <li>- Technology is a tool that must be used as it integrate with all aspects of life</li> <li>- Students are advised on how to integrate ICT during lesson presentation.</li> </ul> <p><b>L4:</b> Same as QL 12 &amp; 13 (<i>did not understand the question</i>)</p>	

## APPENDIX E

### RESEARCH QUESTIONNAIRE – EDUCATION TECHNOLOGIST

Date: \_\_\_\_\_ CODE: QT 01/02/03/04/05/06

Email: \_\_\_\_\_ Phone No: \_\_\_\_\_

#### INTRODUCTION

This is a PhD research questionnaire which aims at investigating the pedagogical integration of Information Communication Technologies (ICT) in Initial Teacher Education (ITE) The purpose of the questionnaire is to determine how the ICT pedagogy of lecturers and students of mathematics, science and technology education influences the process of constructing knowledge and conceptual understanding. Kindly be as open and free as possible. Be assured that absolute confidentiality will be adhered to and under no circumstance will your detail information and any part of your response be divulged to a third party.

#### INSTRUCTION

Kindly respond to all the questions to the best of your ability. Your honesty will be deeply appreciated. Express yourself as much as you wish. The questions have been framed with care and consideration. However, if clarity on any aspect/issue is required, the researcher will be very willing to provide such assistance at any time. A follow-up interview (verbatim) will be organised by the researcher to address issues that may arise from the questionnaire.

#### RESPONDENT DATA

QT (a) Kindly talk briefly about yourself. (Name, Age and Date of Birth may be ignored)

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QT (b) What is your highest academic and /or professional qualification?

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QT (c) How long have you been a staff in this institution and with this section?

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QT (d) Share your experience of assisting lecturers and students with IT services

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QT (e) Briefly share your opinion of where ICT is going in the institution.

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**RESEARCH QUESTIONS (IT DEPARTMENT PARTICIPANT)**

QT1. Kindly tell me about your experience with ICT's

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QT2. The university has introduced the "Blackboard" service which is an ICT initiative. Workshops and courses were organised at different phases for both lectures and students. Kindly discuss the "Blackboard" service.

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QT3. How does the service ("Blackboard") influence teaching and learning?

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QT4. How does the service ("Blackboard") offer opportunities for lecturers to teach for conceptual understanding and for learners to learn with conceptual understanding?

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QT5. Explain how the service encourages creativity, innovative learning and ICT skills development of students as well as lecturers.

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QT6. Discuss the benefits of incorporating the service in curriculum delivery.

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QT7. How do you obtain feedback on the service from the beneficiaries?

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QT8. Share your knowledge and experience on how you assess the service and the beneficiaries.

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QT9. Describe the monitoring mechanisms you have in place to ensure the effective and efficient of the service by both lecturers and students.

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QT10. Discuss how the service encourage lifelong

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End of questionnaire. Thanks very much for taking time off your busy schedule to respond to my request.

## APPENDIX F

### EDUCATION TECHNOLOGIST QUESTIONNAIRE DATA

QUESTIONS	RESPONSES	COMMENT
<b>PART A – PERSONAL INFORMATION</b>		
<b>QT (a):</b> Kindly talk briefly about yourself (name, age and date of birth may be ignored)	<b>T1:</b> I am ██████████, born on the 14 <sup>th</sup> of January 1972 (40 years old). Have teaching background and did BSc degree in Computer Science, that is why I am now working in IT field, but still linked to education, because presently I am working as educational Technologist.	
<b>QT (b):</b> What is your highest academic and / or professional qualification?	<b>T1:</b> BSc. Honours (in Applied Mathematics)	
<b>QT (c):</b> How long have you been a staff in this institution and with this section?	<b>T1:</b> Nine years	
<b>QT (d):</b> Share your experience of assisting lecturers and students with IT services.	<b>T1:</b> - It's a bit difficult to assist lecturers, because some of them especially the older ones are reluctant to learn technology. - With students, its so exciting because you always find that they know much better that what you are showing. They are more interested in technology than their lecturers.	
<b>QT (e):</b> Briefly share your opinion of where ICT is going in the institution.	<b>T1:</b> It is striving to enhance education in this institution, by bringing new ways of teaching and learning through ICTs.	
<b>PART B – BLACKBOARD EXPERIENCE</b>		
<b>QT 1:</b> Kindly tell me about your experience with ICT's	<b>L1:</b> - The experience is more than I can say because I have more than ten years in this field as a student and an employee. - The fact is when using ICTs generally, you do things easier and better than when you are not using it. Most students who use ICTs perform better.	
<b>QT 2:</b> The university has introduced the "Blackboard" service which is an ICT initiative. Workshops and courses were organised at different phases for both lecturers and students. Kindly discuss the	<b>T1:</b> - This is a service provided to university community in order to enhance / improve teaching and learning. - It assists lecturers to do assessment online and upload notes. - It saves time in way that after assessment, the system can mark if is provided with memorandum and give a feedback at once. - It has the capabilities for video lessons, discussions, emailing etc.	

"Blackboard" service.		
<b>QT 3:</b> How does the service (Blackboard) influence teaching and learning?	<p><b>T1:</b> - It assists students to be independent learners and helps lecturers t always be up to date with their tasks. Everyday becomes teaching and learning time, because materials for study are always there for students.</p> <ul style="list-style-type: none"> <li>- Students learn better when using this service in such a way that some even push their lecturers to use the service because it is better.</li> </ul>	
<b>QT 4:</b> How does the service ("Blackboard") offer opportunities for lecturers to teach for conceptual understanding and for learners to learn with conceptual understanding?	<p><b>T1:</b> - "Blackboard" does not replace the traditional way of teaching and learning, but it improves it. In fact, it assists students to prepare on time and the lecturers to be up to date with their schedule.</p> <ul style="list-style-type: none"> <li>- The lecturers should always be there for students to explain for students to conceptualise the content. The system is just there to improve that.</li> </ul>	
<b>QT 5:</b> Explain how the service encourages creativity, innovative learning and ICT skills development of students and lecturers.	<p><b>T1:</b> It assist in improving computer literacy skills in students and lecturers and also encourages lecturers only to be more creative when creating a lesson and or platform for uploading notes.</p> <ul style="list-style-type: none"> <li>- All the lecturers are aware that when planning a lesson, it should be attractive to students so that they are encouraged to visit their pages more often.</li> </ul>	
<b>QT 6:</b> Discuss the benefits of incorporating the service in curriculum delivery	<p><b>T1:</b> - The benefits should be incorporated in curriculum delivery in order to promote a continuous assessment that curriculum needs and continuous assessment works better where there is prompt feedback after students took a quiz / test they should get results as early as yesterday; so the "blackboard" service is there to do that.</p>	
<b>QT 7:</b> How do you obtain feedback on the service from the beneficiaries?	<p><b>T1:</b> We designed some questionnaire that will assist us to get that even though, it is not yuet uploaded on the system.</p>	
<b>QT 8:</b> Share your knowledge and experience on how you assess the service and the beneficiaries.	<p><b>T1:</b> The "blackboard" service ahs got database where you can be able to retrieve the report of what has been going on in the system. The report can be in terms of one individual student, lecturer, course and the overall utilization of the system.</p>	
<b>QT 9:</b> Describe the monitoring mechanisms you have in place to ensure the effective and efficient use of the service by both lecturers and students.	<p><b>T1:</b> The service is having built-in capabilities of monitoring.</p> <ul style="list-style-type: none"> <li>- It can be checked through the reports or opening the activity task manager of the system. You can be able to see how many users are active and who are not and those who never logged into the system for couple of days.</li> </ul>	
<b>QL 10:</b> Discuss how the service encourages lifelong learning.	<p><b>T1:</b> - The service is always there with the back-up and all materials uploaded by the lecturers will lways be there as a reference for lifelong.</p>	

**APPENDIX G**

**GUIDING INTERVIEW QUESTIONS (Students)**

**PART A**

This part has to do with clarification of issues raised in the questionnaire hence vary from participant to participant.

**PART B**

**Questions**

1. How do you use ICT's to get around difficult concepts? How do you use the internet to conceptualise?
2. How do you distinguish between the genuine and the false information?
3. How often do you use your cell phone to search for the meaning of words?
4. How do you use ICT's to monitor your progress?
5. How do your lecturers use ICT to challenge your creativity and innovation capability?
6. What are the challenges you face using ICT as learning resource for your learning progress?
7. Have you ever used your social network for academic purposes? If so how do you do that?
8. What type of ICT do your lecturers employ in their curriculum delivery during your four years of stay in the University?
9. Do lecturers allow you to use your cell phones in class to gather information?
10. What is your take on ICT
11. Discuss how you use ICT's for lifelong learning? If you have a friend somewhere how do you share ideas with this friend
12. How are you prepared for competent ICT use?

## APPENDIX H

### INTERVIEW DATA - STUDENT PARTICIPANTS

#### STUDENT CODED S1 BEGINS

DM65013

(S1)

ADDAM: *Thanks very much for coming. This interview is exclusive and absolutely confidential. Whatever you say will be held in confidence. So feel very free, relax and chat with me.*

STUDENT: Okay.

ADDAM: *This interview is going to be twofold. The first section has to do with the questionnaire that I gave to you and the response that you gave to the questions, which some need clarification on certain issues. The second part has to do with further interrogating your ITC knowledge and background and how best you use ICT's in your studies.*

STUDENT: Okay.

ADDAM: *Let's start with the questionnaire. I asked you in the questionnaire to explain how your ICT use incorporate real world issues and application in learning and your response was that: You use cell phones, to access internet in learning. That is the example of how you incorporate real world activities in teaching and learning. Can you elaborate any further on that? **How do you use your cell phone to relate to real world activities?***

STUDENT: To real world activities. For example most cell phones is for internet, for communication, for example let's say if there is something I don't understand concerning what I am doing in class then I will have to use my cell phone to consult my fellow classmates and go through the internet and make research and try to get some related information concerning those topics.

ADDAM: *Then how do you relate it to the environment where you are working or where you are conceptualising it?*

STUDENT: Actually I mostly do this when studying. I am doing what is academically related. I don't actually go to the extent of relating to the real world situation. Yes.

ADDAM: *Now **how do you use it in your learning program, for example the internet, the projectors?***

STUDENT: When we are doing 3<sup>rd</sup> level and especially 4<sup>th</sup>, for physics they used to give us projects, you write those projects and present using the projector. We do some research and gather information, relevant information, then write that presentation and use the projector. We also go on internet to gather some information.

ADDAM: ***How does it make you creative and innovative using the projector to present topic that you want to discuss with your mates?** You go into the internet to find information, you gather this information, you compile the information, and then you prepare slides and then you present that information to your fellows. How does this make you be innovative and creative?*

STUDENT: It is all just about presenting. It has nothing to do with being creative, but the other things that you can write, most of the things that you are going to talk about on your presentation, you don't have to think about most of them and some, you fellow classmate is just going to read them on your presentation.

ADDAM: *Okay. Now creativity and innovation is not only limited to the designing of a presentations. It could also be how you arrange the information*

*in such a way that it follows a sequence. Now you are going to be a little creative to say that these issues must be discussed first and these issues must be discussed next. So it is a sequence. So that sequence is a creative medium of presenting information.*

**STUDENT:** Okay.

**ADDAM:** *Then we talked about tutorial software and you mentioned Mable software that you use to sketch graphs.*

**STUDENT:** Yes, we used that when I was doing first level. When doing mathematics we used it to sketch shapes of the graph in 3D and 2D dimension and also to calculate matrix, complex matrix.

**ADDAM:** ***How does it challenge your ICT competency?***

**STUDENT:** First you have to understand how to use a computer. If you don't know how to use a computer you are not going to use Mable. Sometimes it is a challenge to understand the software. So you have to understand it. If you do not know how to listen, to write matrix on the program, there is no way that you can add matrix. If you don't know how the graph using the same program, there is no way that you can do the graph. So first of all you have to understand that software.

**ADDAM:** *So usually you must first of all get the background on the software to understand the principles under which it operates?*

**STUDENT:** Even if you can use let's say excel, you have to know how to use excel.

**ADDAM:** ***How do you incorporate communication software such as your e-mail, your chat rooms or discussion forums in your studies?***

**STUDENT:** Most of us students don't, actually have the opportunity to use what Sapp and the Facebook; even if we do we don't usually use it for academic related issues.

**ADDAM:** *Is it because you don't understand that you can use it for study purposes or because you are only interested in the social component?*

**STUDENT:** Maybe it is because we are only..., most of our class we are only interested in the social.

**ADDAM:** *Okay, or is because the culture of ICT use in that context is not familiar or is not adopted by the students?*

**STUDENT:** It might be the reason, but I think it is not the main reason. The main reason is just maybe our mind-set. Maybe we are not used to discuss the academic stuff. Yes.

**ADDAM:** *How do you use your digital sources and resources like your dictionaries and encyclopaedias, like the dictionary on your cell phone?*

**STUDENT:** Mostly I use my dictionary the hard copy, not the cell phone.

**ADDAM:** *Are you aware you can use the dictionary on your cell phone or even on the internet?*

**STUDENT:** I am aware.

**ADDAM:** *Okay. Have you not tried it?*

**STUDENT:** Maybe it is because we are still new to ICT. That is why.

**ADDAM:** *How often do you use your cell phone to access the internet?*

STUDENT: Almost, ja I would say every day I use my cell phone to access it. Almost every day.

ADDAM: *For social issues or academic issues?*

STUDENT: Yes, mostly on social issues, but on academic issues sometimes I can use maybe when I am studying at a place where there is internet, because my cell phone is the smart one, so I can access internet. I can use it and search for information, additional information.

ADDAM: *Now do you know the blackboard service of the University?*

STUDENT: I have never used it.

ADDAM: *So you don't know much about the University blackboard system.*

STUDENT: I was not aware that the University has it.

ADDAM: *I want you to **tell me a little bit about how you use ICT's for lifelong oriented skill development.** In that context I mean that you see when you know how to use the internet, it becomes part of you.*

STUDENT: But sometimes it spoils us, because let's say if you don't understand something, you don't try to get it. You will just go to Google and say what and try to search for information. Ja, that is how I use this internet.

ADDAM: ***Okay. Now have you ever used ICT's to monitor your progress?***

STUDENT: Yes I used to do that when I was doing first level and second level, but now I am no longer doing it. Just maybe I took a two year break. That is why.

ADDAM: *So when you were using it at first and second level, how did you find it? Was it worth using?*

STUDENT: Yes, it was, because it is very interesting, because you always want to, let's say if you got 80 %, you want to get 100 %. You try to answer more questions. Yes.

ADDAM: ***How do you use ICT to engage your peers in learning?** It could be your cell phone. It could be WhatsApp. It could be the social media to engage your peers, your friends, your colleagues in learning and sharing ideas.*

STUDENT: Let's say when I encounter a problem, let's say I was trying to solve this particular problem, but not most cases.

ADDAM: ***So how does it facilitate learning?***

STUDENT: Facilitate learning. Actually mostly it is about getting, let's say if you are trying to solve a certain problem then you cannot get the correct answer or the required answer, you consult, you check with your colleague.

ADDAM: *Thanks very much. That is the end of the first part of clarifications. Then the second part has to do with further probing into how effective you use ICT's actually to advance learning and to produce quality students.*

STUDENT: Okay.

ADDAM: ***Briefly explain the kinds of ICT your lecturers employ in their curriculum delivery? How do they do that?***

STUDENT: ICT. Yes most of the lecturers use the data projectors. When I was busy with my degree, the lecturer used to encourage us to use internet to get some additional information. If you don't understand something you have to go to the internet and try to get some additional information. Ja.

*ADDAM: So how do the lecturers then use the internet? They direct you to sites or just say to you go onto the internet and search? Because most cases if I am a lecturer and I want to direct you to the internet, I am going to give you a site that you should go to this particular.*

*STUDENT: No, they do not give us the specific website. They just say if you don't understand, let's say for example in chemistry, organic just goes to internet, say Google organic and then we just discovered the website and others.*

*ADDAM: Now when they use the data projectors to do presentation and direct you to sites, does it challenge you in any way? Does it motivate you? Does it make you creative?*

*STUDENT: Let's say for presenting the lecturer using the projector. Ja, sometimes it makes the lecture very interesting, but it make things looks easy. Sometimes, personally I think things are easy and relaxed during lectures but when it comes to the test, things are different.*

*ADDAM: Okay, now since you came to the University I think you have been using ICT's. Tell me briefly what type of challenges do you face using ICT's in your learning process, if there is any? .*

*STUDENT: The challenges of using it. Actually it is the ICT itself. For example when I came here for the first time when I was doing first level, so I did not even know how to use the internet. So it was a new thing. It was a challenge on its own.*

*ADDAM: Alright, how do you use ICT's for conceptual understanding and to comprehend what is being taught?*

*STUDENT: Ja sometimes let's say maybe when I go to the internet to go and search, maybe I may find it very easy than the way it is explained it in class. So, when I go into the research than when I was only relying on lecture notes.*

*ADDAM: Can you proudly say that you are competent to use ICT wherever you find yourself?*

*STUDENT: I think I am prepared yes. I think I am prepared, because even last year when I was teaching, I was let's say for examples when you go to prepare the mark sheets then you have to make calculations. I used to use the excel to do everything. So it makes the work easy. So then you don't have to do this manual thing using a calculator.*

*ADDAM: You developed the skills by constantly using the ICT devices and then you can play around with them wherever you find yourself.*

*STUDENT: Some of us are struggling, especially with excel. Ja, for word there is no problem, but for excel.*

*ADDAM: But maybe the University is not doing enough, which I am going to write as one of my recommendations that it becomes IT's responsibility to organise workshops or courses for students on this blackboard.*

*STUDENT: Okay.*

*ADDAM: Okay, thanks very much for availing yourself for this interview.*

*STUDENT: Okay. Thank you sir.*

**END OF STUDENT S1**

**STUDENT CODED S2 BEGINS**

**DM65014 & DM65015 (S2)**

*ADDAM: It is a pleasure to have you. Now I want to assure you that this interview is highly confidential, so you must be relax and let's chat. This*

*interview is going to be in two sections. One section will be to find out more about your responses to the questions in the questionnaire and then the second part will be to find out more about your knowledge of information and communications technologies*

STUDENT: Thank you.

ADDAM: **Brief me a little on your blackboard background.**

STUDENT: Actually I don't have a clue of what blackboard is. I have never used it. I do not know anything about it.

ADDAM: *Are you aware that there is a service or a system in the institution called blackboard?*

STUDENT: Yes, that one I am very much aware of, because I have heard my colleagues talking about it. The ones who are in the other streams they have been trained for that. So I heard them talking about it, but I have never used it and I have never saw them using it.

ADDAM: *So your lecturers, apart from maths sections, never talked about blackboard. They never introduced you to blackboard.*

STUDENT: Yes.

ADDAM: *So you are absolutely knowledge less when it comes to blackboard.*

STUDENT: Yes.

ADDAM: **Now what type of ICT's are you familiar with?**

STUDENT: The ICT's?

ADDAM: *The old ICT's like the television, the videos, the tape recorders, the radios' and the digital ICT's such as the cell phones, the internet, the software and the hardware and the computers. Which of these are you very familiar with in your studies?*

STUDENT: No, in my studies I use the cell phone the computer and the internet.

ADDAM: **What do you use your cell phone for?**

STUDENT: In most cases I use it to communicate with other people and then sometimes I use it maybe to search for information, for browsing actually.

ADDAM: *So how often do you browse on your cell phone?*

STUDENT: Actually more often.

ADDAM: *Very often.*

STUDENT: Maybe I come across something that attracts my mind and then I don't have any clue. Then I go on the internet and search that thing so that I can be more familiar with that particular thing. So I usually use it to browse besides communicating.

ADDAM: *Now do you do that during lecturers as well or when you are out of lectures? For example if a lecturer is presenting something you are not familiar with, do you jump onto your internet on the cell phone to find out more?*

STUDENT: No, actually I usually browse during my spare time.

ADDAM: *What prevents you from using it during lectures?*

STUDENT: In some cases it is not allowed. Some lecturers don't allow you to browse, because if maybe you are used to browse, you don't have a chance

maybe to think if maybe the lecturer is posing a question and then you run to the internet, you don't give yourself time to think. So sometimes I prefer to think about the matter and then maybe if I don't get the answer, then I will go on the internet to search for more information.

***ADDAM:*** *Now don't you also think that if for example I am lecturing and I mentioned a word or terminology that you don't understand, don't you think it will be very appropriate to quickly verify what that terminology means so that your understanding will be continuous so whatever happens after will be very clear. What do you say about that?*

***STUDENT:*** Yes, actually the moment the lecturer present I will be listening. And then I will combine what I heard from him and then relate it to what I got from the internet and then I will try to make out the meaning from there.

***ADDAM:*** *So can you tell me more regarding why lecturers don't allow students to use cell phones during lectures?*

***STUDENT:*** Because they will not be so sure whether the person is actually using that cell phone for that particular purpose. He may be using it for chatting or communicating with someone else. That is why they are forbidden in most cases. That is my understanding.

***ADDAM:*** *How do you mostly use your cell phones?*

***STUDENT:*** Yes, I use it for social chats. I do Mix iT, I do Facebook.

***ADDAM:*** *All for social chat? How often, do you use it for academic work, apart from searching the internet for explanation; do you also use those social networks for academic purposes?*

***STUDENT:*** Yes, actually i used to communicate with my classmates I can say my colleagues. Yes, if maybe I come across information that I realise is important, then I will use it to communicate with my study group via that social network.

***ADDAM:*** *So you are saying that you use social networks also as a chat forum or a discussion forum with your peers?*

***STUDENT:*** Yes.

***ADDAM:*** *How do you use ICTs to obtain curriculum resources? You have got a cell phone with internet, a computer or your laptop amongst others, how do you use these equipment or devices to obtain academic resources?*

***STUDENT:*** Yes, what I think is if maybe there is ever a need for me, I will download any information to be more knowledgeable so that I can provide to the kids.

***ADDAM:*** *How do you use ICTs in your studies? Do you use this equipment, devices, to obtain curriculum resources?*

***STUDENT:*** Yes, I use them. I once downloaded the [NCS], ja most information I did use it.

***ADDAM:*** *Now when it comes to your own studies, do you often use it for studies for further explanation?.*

***STUDENT:*** Yes I do.

***ADDAM:*** *How often?*

***STUDENT:*** I can't say more often, but I used to do it.

***ADDAM:*** *And how does it help your academic progress?*

**STUDENT:** Yes, it really helped me, because in most cases during the lectures the lecturers don't elaborate much. They just give you maybe some hints and short notes. So I have to go there and search more information.

**ADDAM:** *Do lecturers direct you to websites where to obtain these resources?*

**STUDENT:** Some do. *But most of the time you go to find that by yourself*

**ADDAM:** *How does finding things by yourself equip you?*

**STUDENT:** Yes it would mean, I can say it helps me a lot and I have learned a lot from that, because if maybe you find information by yourself, it is not that easy to forget about that information, unlike if maybe you have been told.

**ADDAM:** *So you become independent and you develop the skill of searching for information on your own and not necessarily being told to go there?*

**STUDENT:** Yes.

**ADDAM:** *Do you know anything about tutorial software?*

**STUDENT:** Nothing about tutorial software?

**ADDAM:** *How often do you use the dictionary resources on your internet or your cell phone?*

**STUDENT:** Dictionary resources?

**ADDAM:** *Yes like the dictionary (Wikipedia) which is built in your cell phone (smartphone) and the encyclopaedias*

**STUDENT:** Yes, I use the dictionary.

**ADDAM:** *The hardcopy?*

**STUDENT:** The hardcopy yes. I have never used the installed one.

**ADDAM:** *How do you identify websites that could give the information you want or the appropriate search engine?*

**STUDENT:** I have Google as my only search engine and then in the Google there are advanced search. I usually used to use the advanced search unlike that Google.

**ADDAM:** *So the University network allows you to use a particular search engine because others are blocked.*

**STUDENT:** Yes, most of them are blocked.

**ADDAM:** *So you are skilled in this search engine.*

**STUDENT:** Yes, and some of them require you to subscribe.

**ADDAM:** *How do you use ICT's for lifelong oriented skill development?*

**STUDENT:** I did not have a clue actually what to say. Maybe if you can elaborate.

**ADDAM:** *Okay, now what I mean by lifelong oriented skill, there are certain skills, for example searching the internet is a skill. And this is a lifelong skill that you developed in the process. Everywhere you go you can apply the skill that you have developed in the cause of your studies (to search information).*

**STUDENT:** I am not sure that I will answer it right, but this ICT, actually I think I will use it maybe to equip knowledge or to get more knowledge.

***ADDAM: What types of ICT devices do your lecturers use in curriculum delivery and how do they use those devices?***

***STUDENT:*** They use the computers and the overhead projectors. Yes, these are some. Okay they use them both. Some use the data ones. Some use the overhead projectors.

***ADDAM: How does that challenge you?***

***STUDENT:*** Sometimes you will find if maybe they are presenting their lectures, you will find maybe they just scroll and then you don't have enough time to absorb that knowledge or due to time, you will find that they just maybe there is one sentence and then they try to explain it a little further, but when you try to maybe to write down notes or something, you will find that they have already passed that slide. So you miss that information. So that is the only challenge that I am experiencing.

***ADDAM: Have you ever used the data projector to do presentation via power point yourself?***

***STUDENT:*** Yes, I did use it during the presentation. We were presenting and then we used the data projector with the power point.

***ADDAM: How does that build you?***

***STUDENT:*** Yes, it really builds me, because there are certain skills that I have developed. Maybe to put your work in order, organise yourself and then to present the information.

***ADDAM: So you have got that skill of using ICT's, especially the power point? Have you ever used ICT's to evaluate your progress?***

***STUDENT:*** Evaluate my progress? No. I have never used.

***ADDAM: What I mean is, using ICT resource to test your understanding.***

***STUDENT:*** I have never used it before, because the activities may be that I found in the internet based on a certain topic, you will find the activities and then you find there may be the summary or the topic and then you find the answers below. So I take that answers and then Google them again to find the answer or maybe consult my textbook or my guide to respond to that question.

***ADDAM: So you have that skill of challenging your intelligence. My last question for you is: can you confidently say that you've got enough ICT skill and ready or competent to use as ICT in the classroom?***

***STUDENT:*** Yes, I can't say that I am that much competent, but what I know is that I can use some ICTs, but I can't say that I am that much competent, because there are some of the things that I were some areas that I have not been exposed to.

***ADDAM: Which of the devices that can you proudly say with confidence that you are good at?***

***STUDENT:*** Yes, the computer and the data projector, yes these ones I can say I am good at actually.

***ADDAM: Okay. Right thanks very much my dear. I really appreciate your response to the questions that I have raised and I am very proud that you are one of my participants.***

***STUDENT:*** Thank you and I am also actually grateful that maybe I have actually helped.

**END OF STUDENT S2**

## **STUDENT CODED S3 BEGINS**

DM65012

**(S3)**

ADDAM: *Sir you are very much welcome to this interview session. It will be in two sections. One section will have to address your response to the questionnaire, because there are certain aspects I need clarification and the second part has to do with further probing into your ICT background and ICT use in the curriculum studies. I want you to feel at home, to be at ease and I want to assure you that whatever we say here is highly confidential.*

STUDENT: Okay

ADDAM: ***How do ICT's change your attitude towards your studies?***

STUDENT: As you can see during the secondary, we only received the textbook. They were limiting us and then now if I get a topic from the class, I go further. I get into the internet search the topic to obtain lots of information.

ADDAM: *With the background that you have acquired, how will it change your approach to teaching if you should be in a school where these facilities are available?*

STUDENT: Okay what I can do is that I will give learners opportunity. It is like if I check out the topic I will just explain it just a bit and leave the rest to my learners, so that learners can go into the internet. They can go and interact with different resources to get more information. I will then clarify or consolidate at a later stage.

ADDAM: *You are going to challenge the learner's thinking ability?*

STUDENT: Yes, at least that will create learners independence. They can go and find things on their own and not depend too much on the teacher.

ADDAM: ***How do you incorporate ICT's in your studies to advance your knowledge?***

STUDENT: Okay it is like mostly we use the internet and then in the internet when you search a topic there, then you will find different resources which bring different ideas. In that way I am able to get a lot of information and different ideas and then at the end I combine them to get something solid.

ADDAM: *So you are using this ICT's and it does benefit you a lot.*

STUDENT: Yes.

ADDAM: *Can you briefly discuss some of these benefits?*

STUDENT: Okay when I go to class I can even go to class over prepared. I can prepare before, because there is a lot of information on the internet and so on and so on.

ADDAM: *In terms of making learning easy and comfortable, what do you say about that?*

STUDENT: Okay on the net there are different software, like if I am doing mathematics, as I come across a problem, there are calculators that can show every step. Like there is this calculator which deals with integration. Then when you just punch that calculator, you find the problem and it will give you step by step and they are calling it a step by step integration.

***ADDAM:*** I may call it possibly as tutorial software. It gives you explanations and after it gives you some exercises and then you can evaluate yourself whether you are getting the concepts right or not.

***STUDENT:*** After the explanation, I take another problem, and solve on my own. Then after, I refer to that calculator.

***ADDAM:*** Now you talked about using the calculator on the net to conceptualise. ***The curriculum resources that you obtained from the net help you to study. How often do you use such resources?***

***STUDENT:*** Actually I use them when I experience a problem concerning a particular exercise. Then I will make sure that I find the solution at the end.

***ADDAM:*** ***Do you share ideas? Do you share knowledge? Do you share information with colleagues on the net in a discussion forum or on your cell phone?***

***STUDENT:*** Yes, we do on Facebook. A classmate may ask a question, I will download it solve the problem and then forward the solution to the person. I have documents with lots of information that I share through g-mail with other student

***ADDAM:*** ***How does this sharing of knowledge help you in your studies?***

***STUDENT:*** Yes, it helps us a lot; I can say yes we succeed actually.

***ADDAM:*** ***Okay, in other words it helps you to get a better understanding of whatever you are doing, because you have different views from friends and sharing that knowledge.***

***STUDENT:*** Sharing the knowledge, yes.

***ADDAM:*** ***How do you take advantage of ICT tools or devices as a motivational tool and creative tool to advance your creativity and innovation?***

***STUDENT:*** Okay, as a motivational tool, yes let me think. : Yes, once you get information or maybe you have been reading something or maybe you have been searching for something, and then once you go onto the internet, and when you get the answers, it will motivate you and one day if you need more information, you will know the internet, may assist.

***ADDAM:*** ***With hands on ICT materials, devices, like the projectors, the internet and others, even your cell phone, how do you incorporate those in your learning program?***

***STUDENT:*** On the internet. Yes, in most cases I can go into the internet and then we search for information and then summarise and put them in the power point and then after putting them on the power point and present to learners as a summary.

***ADDAM:*** ***How do you design representation and make it friendly to the learners.***

***STUDENT:*** Yes, like as when you present it to learners. I will give example of information of water and oxygen combining to, reacting to form, then you can even show the animation to learners, that will make them to understand better.

***ADDAM:*** ***The digital resources like the dictionary, the encyclopaedias on your phone or on the net, how do you use them?***

***STUDENT:*** Yes they help, especially in drama. Sometimes.., yes, in drama they help.

***ADDAM:*** Okay. So if for example your lecturer is teaching something in class and he mention a word that you are not familiar with, do you quickly jump onto your mobile device?

***STUDENT:*** Yes, sometimes.

***ADDAM:*** And how does that help?

***STUDENT:*** Usually you will find that maybe in the class we are all struggling. You just quickly go into the net and I find something. Once I bring that, even though it is not that clear, but once I bring that into the class, then at least some of the fellows will get at least the understanding or they will get a way at least to explain that concept. Ja.

***ADDAM:*** ***How do you use internet by selecting suitable websites to support your learning?***

***STUDENT:*** Sometimes even the textbook we read, or the document that I read may be a combination of different sources. You will find that at the end they indicated or if you want to understand, the website and so and so. And even in Facebook or other social networks, when you are talking with maybe other students, they will tell you okay this one is good if you need mathematical associates or chemistry resources, then it is where you get them.

***ADDAM:*** ***How do you use ICT for collaborative and cooperative learning?***

***STUDENT:*** Okay, with computers I can prepare a power point. If there is something, then I can share with other people and even the cell phone works

***ADDAM:*** One way you can learn in modern times is via the use of technology. Now ***how do you use technology to facilitate lifelong learning?***

***STUDENT:*** Okay, learning does not stop. The internet is the one which is popular and even in retirement, I can still have access to the internet and read and find current information. Yes, current information and discoveries especially in science, because they always discover things and so on.

***ADDAM:*** ***What kind of ICT's do your lecturers employ in their curriculum delivery and how do they use them?***

***STUDENT:*** One of them which almost every lecturer is using is the projector. They used to present information in summary and then they used to send us information, information and material through the e-mail and one of them is the blackboard. Through blackboard I received notices, announcements from my lecturers.

***ADDAM:*** Now does it help?

***STUDENT:*** Yes, the blackboard was very helpful, because sometimes I do not attend a class, I just stay in my room and with my laptop I access the notes and materials.

***ADDAM:*** ***Now how do lecturers use ICT's to challenge your creativity and innovation potential? Does it challenge you in any way? Does it make you creative in any way?***

***STUDENT:*** I think it does. Yes, say if the lecturer teaches us how to use the power point, but with the power point at least we have done it in computer literacy. Yes.

***ADDAM:*** ***What are some of the challenges that you faced using the ICT's in your learning program?***

***STUDENT:*** Yes, the problem is with social network skills, sometimes you become addicted, you become more and more addicted. You will find that you are no more concentrating much on your educational issues. You are focussing on

social network, chatting and so on. Sometimes you spend a lot of time searching unnecessary information instead of doing something academic.

***ADDAM:*** ***How do you evaluate the blackboard service? Do you think it is a good way to go or what is your take on that?***

***STUDENT:*** Yes, I think it is a good way, because if I remember well one of the aim of the blackboard was just to reduce contact with the lecturer. Remember you can spend time on activities and so on the blackboard. I can say a chatting room where you can talk to your friends and share information and then you can have your own time to tackle the activities that you have been given by the lecturer.

***ADDAM:*** ***Okay, my last question for you, you are going to the world, you are going into the market place now, how are you prepared for competent ITC use?***

***STUDENT:*** I think at times I will integrate it in the curriculum. So far with the experience from this University, I think I can integrate it. Yes, I am ready. I think I will give learners projects that will lead them to at least interact with the internet so to prepare them for tertiary education. At least if there is access to computers, you can teach them how to use different software on the internet. You teach them how to search for information, because I remember when I was at school, you will find learners have cell phone to search for information, but at the end they don't get what they are looking, because they don't how to use the device for academic search.

***ADDAM:*** ***Alright thanks so much for coming. I really appreciate your input. Thanks so much.***

***STUDENT:*** I am glad. I think there were some of the questions I could not come with the answers. But any way I am glad.

### **END OF STUDENT S3**

### **STUDENT CODED S4 BEGINS**

**DM65006** (S4)

***ADDAM:*** ***Thanks very much for coming. Thanks so much for responding to my questions as well. This interview is going to be twofold. The first section is to clear up certain responses to the questionnaire and the second part is probing for further understanding of your ICT knowledge and how it could be used to advance quality learning. So don't be scared to say anything that you feel like saying and when you have anything to ask, you are free to ask. Now this is a semi structured interview which means that I could have asked questions from your response as well.***

***STUDENT:*** Alright.

***ADDAM:*** ***When I asked you of how you use ICT to obtain curriculum resources for maths, science and technology, your response was that I use ICT to obtain notes for maths and physical science from the internet. Kindly explain how these resources (notes for maths and physical science) that you obtained, assist you to advance conceptual understanding.***

***STUDENT:*** Okay. When you learn something from the class, you will find that there is that limited knowledge, but you are given maybe a website and then when you go to get that notes, then they relate to what happened in class. Then you develop a better understanding of that.

***ADDAM:*** ***How often do you do that?***

**STUDENT:** Very often. Every module I do like that.

**ADDAM:** *Every module you visit the internet. Do you share this knowledge with your friends, your colleagues?*

**STUDENT:** Yes.

**ADDAM:** *In a discussion forum or in a group?*

**STUDENT:** Actually when I get something I just send an e-mail to those that I know they are connected to the internet, and when they get something they e-mail me back.

**ADDAM:** *So you are actually engaged in a discussion, sort of a group discussion?*

**STUDENT:** Yes, something like that, via the internet.

**ADDAM:** *Are those colleagues internal or are they external?*

**STUDENT:** Most of them are my classmates.

**ADDAM:** *Have you ever tried to do that with those who are not your classmates, like your friends in other universities, who may be doing similar module, that you got information from the internet which you think is valuable to share with them, you disseminate this information.*

**STUDENT:** No, only this one guy that I used to study with. I think he was doing engineering, and then we were doing the same maths. So he used to send me some notes even in physics. We were doing the same thing in that semester, electronics. We used to share ideas and notes.

**ADDAM:** *So you were engaged with both external and internal discussions with friends and peers. Now can you say that this resources that you obtained, influence your studies as well as your academic progress?*

**STUDENT:** Yes, very much, it does.

**ADDAM:** *So you use the ICT to generate a discussion forum as well?*

**STUDENT:** Yes.

**ADDAM:** *How do you use ICT's to get around difficult concepts? How do you use the internet to conceptualise?*

**STUDENT:** Oh what I do, let's say for example I am doing something that is very difficult. I don't understand. I will write that thing down and when I get to my room, I will open my laptop and I will Google that thing. So the internet will give a lot of responses and everybody will be explaining the concept in his own way. So take the one respond, and try to generalise the general idea of what they are saying.

**ADDAM:** *How do you distinguish between the genuine and the false information?*

**STUDENT:** Like I said, I take it; let's say for example we are looking at the concept "energy". So I look at what the books say about energy or the concept that are dealing with energy. Then I go to the internet. Like most of the time when you Google the internet, you will just put a simple statement. There will be certain page ask.com, and then people will have to ask the same question. I look at the book, I look at those answers and then I Google more. Some you will find that they are just.., even when I say lecture notes, it is going to give a lot of lecture notes from different universities' lecturers about the same concept and then from there I can say these guys are talking about the same thing then I decide.

**ADDAM:** *That is a very good skill. How did you learn that skill?*

STUDENT: Yes, I have just learned to do that.

ADDAM: *By practise?*

STUDENT: Yes, like using it. I was lucky enough when we came here; I was well advance with the internet and stuff like that. So during first year, they will give us an assignment, and guys look at the books. When they are not giving you sufficient information, I will go to the lab and search for the information. I will find the information and then I write it down trying to analyse it then type it.

ADDAM: ***Have you tried to assist your colleagues who are weak with the use of internet to search for information?***

STUDENT: Yes, but in the past three years it was like that most of them they were afraid, but I think this year and last year a lot have developed the use of the internet, everybody has a laptop. Internet is there even in the rooms so they go through Facebook, they try to get..., like they get used to the internet.

ADDAM: ***How often do you use your cell phone to search for the meaning of words?***

STUDENT: Yes, we do that often in method class. We find that we are learning something or you just want to solve a problem, but we did during our high school days, so you will just take your phone, maybe Google what and then you get it.

ADDAM: ***Now I mentioned learning management systems, which happens to be the blackboard, within our context, in our institution environment. That is what we are supposed to be using to manage our learning where you have interaction if you are a lecturer. Then you get a feedback from your lecturer or you get notes from the lecturer and then you share with your peers if there is an issue that you think is interesting. Have you been doing that?***

STUDENT: Yes, the last two years we were using blackboard in mathematics to get some previous question papers and some tasks. You will find the task, do it and send it via blackboard again.

ADDAM: *How was that?*

STUDENT: It was good; because I remember when we were doing practicals I had to type a question paper for mathematics. So we just used those skills. I go to a question, I put it there. Rather than taking the paper, feedback comes.

ADDAM: ***How do you use ICT's to monitor your progress?***

STUDENT: Monitor my progress? No, I can't say.

ADDAM: ***How do your lecturers use ICT to challenge your creativity and innovation capability?***

STUDENT: Yes, what I can say it is like they use it for example when you are given an assignment, you will have go there and type it and then they will give you font and that. So I think they are trying to develop us there.

ADDAM: ***Is that the only way they develop you?***

STUDENT: Yes, I can say that, because that one of using, communicating with us via blackboards or the internet, it was only used by one lecturer.

ADDAM: ***Okay, what of the issue of presentations? Because if you are doing a presentation you need to design your material before you do that presentation. So you go and create your material. Have you ever tried that as well?***

STUDENT: Yes, presentation, we were doing presentation in the curriculum studies. So the presentation was in a group, but that one I don't like because it was in groups. So when you are doing something in group, you normally engage all participants, but what we were doing, they will tell you okay use power point, come up with slides, and then you would have a document of the whole presentation.

***ADDAM: What are the challenges you face using ICT as learning resource for your learning progress?***

***STUDENT:*** The only challenge is if you depend too much on ICT, you are going to lack the skill of reading a book, because reading a book and going to ICT are two different things, because sometimes you will find that you are compelled to read a book, because the ICT or the internet is not there. Once you depend too much on the internet, you are going to have a problem, because you will always go to Google, even if a simple thing. When you can just take a book and read.

***ADDAM:*** We say that ICT provide current information compared to books. I was reading a material which was dated 1994 and when I looked on the internet for the same information, this information differs from what the book is saying.

***STUDENT:*** Yes, I agree with that one, but reading a book there are certain skills that you obtain, by just reading a book. You get to know something by just reading a book. While you are not focussing on the knowledge being new or something, but just reading a book, you get something. You will find that you no longer know how to read a book in front of people, because you are just used to the internet.

***ADDAM: Have you ever used your social network for academic purposes?***

***STUDENT:*** Yes. We do that one.

***ADDAM: How do you do that?***

***STUDENT:*** Like you may find that I am on Facebook for instance and then normally people will share the information on Facebook. Then he will simply inbox me the web page that he got the information and then I will go to the website.

***ADDAM:*** It is quite interesting to know that, because many people use the social network just for social chats.

***STUDENT:*** No, I use it also for sharing information.

***ADDAM: The blackboard service, how do you evaluate?***

***STUDENT:*** I can say it is very appropriate in furthering communication especially, because when you are on blackboard you can communicate with a lecturer or your colleagues any time. It is also reinforce learning outside the classroom.

***ADDAM: What type of ICT do your lecturers employ in their curriculum delivery during your four years of stay in the University?***

***STUDENT:*** They use the internet, projectors, mostly projectors and computers. Those ones are the core they are using.

***ADDAM: Do they allow you to use your cell phones in class to gather information?***

***STUDENT:*** Not during class, but presentations and discussions you are allowed.

***ADDAM: What is your take on ICT?***

***STUDENT:*** I can say that I believe in ICT. I love ICT too much. I spent most of my time in front of the computer. Nine hours I spend in front of the computer, but the problem with ICT like, once you becomes addicted to it, it becomes a problem, because everything you want to do, you want to do it via ICT and now it becomes a challenge. That is the problem with kids or adults. They do not want to see the good side of it. You can use this thing to study or to do work. Like for instance when you are talking about ICT, applying it in high school, learners or those kids, they just know that okay if I have a phone that has internet, I am going on Facebook. They don't know that I can use this cell phone to Google

information. The internet for them is for Facebook and it becomes a problem in teaching using that Facebook, but ICT is good for transformation.

***ADDAM:*** *Discuss how you use ICT's for lifelong learning? If you have a friend somewhere how do you share ideas with this friend?*

***STUDENT:*** Yes, I can say that like I can use it to communicate for example, I am going to be teaching science. I know that sometimes there will be some concept in science or some chapters that I am not cool with or I am not good at. So with this ICT I can also communicate with my colleagues, you can say help me here. I am going to teach this chapter this time, but I don't understand. That one may be good in the chapter. He may send me feedback and say don't worry, I will give you my notes or I will refer you to this website that I saw. Then you can use that one. So I think we are going to work with ICT for a long time.

***ADDAM:*** *How are you prepared for competent ICT use?*

***STUDENT:*** I think I am competent. I have been using ICT daily. So I am competent.

***ADDAM:*** *Well skilled.*

***STUDENT:*** Well skilled.

***ADDAM:*** *You can employ it.*

***STUDENT:*** I can employ it. I can work with it. I can utilise it.

***ADDAM:*** *That's ends the interview and thanks for your presence. I wish you all the success wherever you find yourself and don't forget we need you, wherever you go, you must come back to us.*

***STUDENT:*** Thanks as well.

#### **END OF STUDENT (S4)**

#### **STUDENT CODED S5 BEGINS**

**DM65010** (S5)

***ADDAM:*** *Welcome to this interview and be assured of confidentiality. So be very free, relax and enjoy the discussion as best as you can and to the best of your ability.*

***STUDENT:*** Okay.

***ADDAM:*** *Now this interview is going to be twofold. One is to obtain a better understanding of some responses to the questionnaire and then the second part is a further probe into your ICT background and knowledge and how best you use ICT to advance your learning and how you are equipped for the big life ahead of you.*

***STUDENT:*** Okay

***ADDAM:*** How do you see ICT in today's world?

***STUDENT:*** First of all, when we look at ICT and the world as two different things, we can see that the world now is more advanced due to the improvement or advance technology. So incorporating ICT into curriculum will make it easier for us to be able to see how we adjust to the world. So it is more of moving from the classroom well equipped with the weapons that we need to sharpen our society. So that will be more beneficial.

***ADDAM:*** Okay. Now as a follow up to that, ***have you been well equipped with ICT's in your studies that can enable you to face the world which is full of technology?***

***STUDENT:*** Okay. When I look at how we have been equipped in our school, somewhere somehow we don't have that much knowledge of ICT. So for myself, I normally go to the internet, search for relevant document on how best I can use ICT in my practice so in that way it helps me, because I cannot just say the school did not bring this issue to us. I have to go extra mile, search for relevant information on how ICT can help in my practice.

***ADDAM:*** ***How do you use ICT's to obtain curriculum resources, for maths, science and technology?***

***STUDENT:*** When we look at the core issues of ICT and also look at what is happening on our classrooms, we realise that there is a need to download resources relating to what is happening in our classrooms. So for instance when we teach physical science, you will find that the school is not well resourced. So we can use cell phones to download certain resources. For instance you will find yourself teaching topic like atoms. Learners don't know what atoms looks like. So we can use cell phones to download pictures of atoms so that learners can conceptualise what they are learning and refer to textbooks on line. So we can use those, like cell phone facilities to access those resources other than saying we don't have enough textbooks, whereas we do have portable devices that can help us to download resources.

***ADDAM:*** ***How do you use ICT's in collaboration or incorporative learning or discussion forum?***

***STUDENT:*** Using that is not that much difficult, because what is needed is for you to be able to post current issues that can be debated and when we talk about debate, obviously we are looking at various issues or various opinions of people. So other than people coming together, maybe in a particular room debating issues, I can sit at my own space, you can sit at your own space and still be able to communicate through ICT devices and that would be more of engaging us with relevant issues arising in our environment.

***ADDAM:*** ***How do you use ICT to motivate yourself?***

***STUDENT:*** ICT makes me to be closer to my learning. Using it is more easy and flexible other than maybe relying on textbooks and other things. ICT is just at my disposal. No need for too much stuff. It is only you and the device. So it makes it simple and easy.

***ADDAM:*** ***Does ICTs challenge you***

***STUDENT:*** Actually it makes me to be attached with the content and also issues arising out of the society.

***ADDAM:*** ***Does it also expand your knowledge in other words***

***STUDENT:*** Yes

***ADDAM:*** ***How does ICT expose you to the world around you for personal growth as well as academic growth?***

***STUDENT:*** Learning is about exposing and sometimes when you find yourself being limited by particular resources, the resources that you have at your hand, it becomes so difficult for you to access, but when you have got ICT devices you can quickly browse the information that you are looking for. You can quickly find additional resources that can help you to understand the issues that you are learning about and also advance in becoming a scholar.

***ADDAM:*** ***Does ICT relate you to the world? For example if a topic has been taught, and you want to relate this topic to the real world or real environmental issues, does it do that? To make issues more practical than you see it just in the textbook.***

**STUDENT:** When we look at science specifically, it is more of a practical subject. So using ICT devices, we can be able to see how this information is relevant to what I have encountered in real life situations other than in a classroom situation.

**ADDAM:** *Alright. Yes, one question I also asked about is to discuss how you incorporate tutorial software in your learning. **What do you understand by tutorial software?***

**STUDENT:** On that one sir I am not much clear about tutorial software.

**ADDAM:** *Now tutorial software can take different forms. Some could be purchased, which you download on your system and you use it, but then for a student like you, it may be quite expensive to download software for every topic that you have been taught. Otherwise there are other free tutorials software on the system. If I have been taught a topic, I will Google, get explanations and exercises given there. You do these exercises submit and you get instant feedback. This helps you to measure your progress.*

**STUDENT:** Yes I can measure the progress.

**ADDAM:** ***How often do you use the cell phone chat systems to advance academic work?***

**STUDENT:** I use it regularly.

**ADDAM:** *To discuss issues?*

**STUDENT:** Yes, sometimes we discuss issues and then we also try to solve particular problems using chatting devices.

**ADDAM:** *To discuss academic work. Not only for social.*

**STUDENT:** Not only for social.

**ADDAM:** ***What kinds of ICTs do you lecturers employ in their curriculum delivery and how do they use them?***

**STUDENT:** The first one is internet. So with internet they just give us relevant websites to check the information and to check another additional maybe tasks or activities that we have to do and the other one that we use is blackboard of which we did not have that much experience on, but otherwise we were able to access material from the blackboard system and be able to do the problems.

**ADDAM:** *With the internet service, the lecturers refer you to specific websites. Has the University got other search engines available for you, or they blocked many of the search engines?*

**STUDENT:** Other search engines are blocked.

**ADDAM:** *Does the search engines available give you adequate information on what you explore?*

**STUDENT:** No, actually sometimes the information it is limited. It is more of what is happening inside the textbook. So maybe the one that they are blocking actually are the ones that we need. But the unfortunate part is that cannot go there and tell them to unblock them.

**ADDAM:** ***How do lecturers use ICT's to challenge your creativity and innovation potential or capability?***

**STUDENT:** It becomes clearer to you that you need to be aware of particular issues. For instance when you teach it is not about using chalk and stuff like that. You can come into the classroom, bring the topic, use cell phones, look at additional information or to get the compliment of the lesson that you are teaching. So it becomes more of exposing you to the issues arising.

***ADDAM:*** *To explore further, do lecturers give you exercises that involves using ICT's, to be more creative and to be more innovative? Do they give you such exercises or assignments or task that engage you with ICT's or need ICT devices to develop these task and to be more creative?*

***STUDENT:*** Yes, basically we were doing the other one with method of physical science. That was more about reconstructing the creature. So for you to be able to reconstruct that creature, you have to get relevant information. So ICT becomes a bridge to lead us to the other side of getting the relevant information that we can use. So in that way you become more creative and say okay this one can work with this one and this one can work with this one.

***ADDAM:*** *When using ICT's obviously you face challenges. Can you numerate a few challenges that you face in your study program or in your learning process using ICTs?*

***STUDENT:*** With ICT devices, for instance when you rely on cell phone when we have to check relevant information, the battery can go off at any time. So when the battery goes off you are also off. So when you browse information on the internet, if the GPRS service is not working, you are not going to work. So it is one of the challenges that you come across with.

***ADDAM:*** *How do you use ICT's for conceptual understanding and to comprehend what is being taught or has been taught?*

***STUDENT:*** Let me specifically respond to that one looking at science. Sometimes you go to the classroom and teach learners about reactions and you will find that the school is under resourced. There are no chemicals that you can use, you can use ICT devices to demonstrate to learners, to let learners see how that reaction proceeds. So in that way learners observe what is happening with that reaction. So their conceptual understanding becomes more enhanced and that will make them to be aware of what you are actually teaching.

***ADDAM:*** *So in other words you are saying that ICT helps conceptualise the issues which are more abstract by bringing it home to the learners to visualise what is happening?*

***STUDENT:*** When we don't have resources at school, we become more of procedural. We give learner procedure other than the conceptual knowledge that they need. So ICT is to give them the conceptual understanding of which they will be able to draw out the procedural understanding.

***ADDAM:*** *How do you use ICT's to present information?*

***STUDENT:*** Sometimes we can use the data projector. Learners can see what is happening and also when we allow learners to use cell phones to be connected or to be attached to their learning, it becomes easier for them and also it becomes more enjoyable. As learners enjoy what they are learning about, so do they become more attached to their learning.

***ADDAM:*** *Don't you also think that exposing or given the opportunity to learners to use cell phones in the class or during learning process may also be abuse during the learning program?*

***STUDENT:*** I think one of the factors that disadvantage people to use this ICT devices in classroom, is that they are looking at the negative side. They are too much attached to the negative side, but they don't actually look at the positioning of this device. So allowing learners and giving them the procedure, will allow them or train them to use these devices accordingly and they will benefit.

***ADDAM:*** *Explained how you use ICTs for lifelong learning, to discuss your own ideas with your friends, your colleagues, to evaluate yourself and to reflect on your learning experience?*

STUDENT: With regard to lifelong learning, there are issues that you develop along the journey of learning. So as you develop those issues you can quickly get into your colleagues' box, post the topic, let them engage and see how their views relate with what you have along the way. So that is basically how it can help.

ADDAM: *How would you evaluate the blackboard service which you did just for a very brief period?*

STUDENT: It is a powerful tool and makes us to be attached to what we are doing. We can work at our own pace and we can also work at the lecturer's pace, because once they give you the activity they will tell you that we need this activity at this particular time. So we become more eager to get into those activities.

ADDAM: *Alright, my last question for you is, how prepared are you for competent ICT use, because going into the world of work, are you sure that you are competent that you can use ICT's effectively.*

STUDENT: Competency comes along with engaging regularly with what you are doing, but so far I have realised that I can be able to use ICT devices into my practice. Even though I did not have that much exposure, but like one is the cell phone, because everyone now has got a cell phone. So cell phones can be used purposefully. Actually they contain more information than the textbooks. So I prefer using it, but I will give learners boundaries, otherwise you will find them chatting.

ADDAM: *Okay thanks very much sir. It is a pleasure to have a chat with you. I really appreciate your input.*

STUDENT: You are welcome sir.

ADDAM: *Do you have any comment to make?*

STUDENT: No the only thing that I can say for now is that I hope you will attain your goals that you were seeking to achieve with this program and all of the best.

ADDAM: *Thanks very much. I really appreciate that.*

#### **END OF STUDENT S5**

#### **STUDENT CODED S6 BEGINS**

**DM65009**            **(S6)**

ADDAM: *You are very much welcome to this interview. You must feel relaxed. It is a chat between the two of us regarding your ICT knowledge and how lecturers use ICT to advance your knowledge and how you use ICT to advance your learning program and progress. If you have any questions to ask in the cause of the interview, you are free to do so.*

STUDENT: Okay.

ADDAM: *Now this interview is going to be in twofold. I am going to find out more about your response to the questionnaire on areas that I am not clear about. Then the second part has to do with getting deeper into your ICT involvement and knowledge regarding your learning.*

STUDENT: Okay.

ADDAM: *Now going on with the question that I asked on how you incorporate the following in your learning program, projectors and others, and then your responded: - during presentation I use projector, a data projector and a laptop*

and sometimes the lecturer requests us to bring the laptops into lecture sessions so that we can access information which will help us have a better sense of what we are learning about.

STUDENT: Yes.

ADDAM: **Using the projector and the laptop for presentation. How confident are you with that context?** How conversant are you with these resources? How equipped are you with these resources and at any point in time you can have confidence and use the resources?

STUDENT: I am confident enough in using the laptop and computer especially the laptop, my knowledge with the laptop enables me to help people. The time I got used to the laptop it became so easy, because it was a new thing to me and I just tried everything that I could learn from it and when it comes to presenting with the project I am not well equipped, but I just learn by trying.

ADDAM: **Do you design your material for power point presentation?**

STUDENT: Yes, the material on power point I design myself.

ADDAM: So you are very comfortable with designing and innovation?

STUDENT: Yes.

ADDAM: How to design your material so that you can easily do a good presentation with it?

STUDENT: Actually I don't just take the material as it is and present it, because sometimes I come across certain concepts that I won't be able to explain. So I prefer, even though I may have materials, some materials from some people, I prefer like going through the material and then making it in a way that I will be able to explain it.

ADDAM: So you are very conversant with innovation?

STUDENT: Yes.

ADDAM: To present. Then one other area you did not answer was tutorial software and then you said unfortunately I have no idea of tutorial software. Now do you know what software is?

STUDENT: I know software?

ADDAM: What is software?

STUDENT: Software to me, in the context of a computer I know it is a program that you install on your computer. A program that you have to install on your computer.

ADDAM: Do you install software on the computer that you can access anytime?

STUDENT: Up to so far, my knowledge on software is that every software have to be installed.

ADDAM: Now in installing software, how does it benefit you if you install it on your personal computer?

STUDENT: It lasts longer and then I don't know that much. I prefer software that I have to install, unlike the one that I keep on the desktop, because sometimes you may delete it unaware. So if I install it, it is in the operating system then it stays longer.

ADDAM: So if for example, there are so many software that you can download on the internet. Some are free and some you purchase them. Now if you take for example, I have taught a lesson. You go to the net to analyse and you find

information and then you look at it and say this can help me understand the lesson better. You work through it. So you are working through tutorial. They give you a list of questions, explanations, you work through them and then at the end they give you an exercise to test your ability to determine your level of understanding of what you are going through. So with that software, you can download it and keep it on your system, or you work with it and then you move on.

**STUDENT:** Yes one time I remember we used it in [EDST], yes it was like sort of questions, multiple choice questions and then we have to answer the questions. Then at the end you submit and then you get the feedback.

**ADDAM:** Okay.

**STUDENT:** Yes, even in maths sometimes I come across them on the internet and they give me the problem and they say provide the solution and submit and then they give you the feedback.

**ADDAM:** It is very common on the internet.

**STUDENT:** Yes.

**ADDAM:** **How often do you use your cell phone as a learning tool?**

**STUDENT:** My cell phone? Sometimes I can use for the internet like if the system is down, but it depends on the advancement of the cell phone. How advanced it is, because some cannot access internet. It takes long just like mine. I don't use it like to access information on the internet. I only use my cell phone calling. That is all.

**ADDAM:** So your cell phone is merely for making calls?

**STUDENT:** Yes, communication.

**ADDAM:** But you know you can use social media for academic work.

**STUDENT:** Yes.

**ADDAM:** **With one year access of the blackboard, can you make a comment on it, how did you benefit from it and how does it equip you?**

**STUDENT:** It helps us a lot like you got the question, the previous question papers, and then she gave us tasks and I remember she also gave us the.., like sort of pretext and you have to work on in terms of the time stated. And after completing the test, she responded and if you are done with the pre-test, then you can come and get another material. Like all the previous question papers are placed on the blackboard.

**ADDAM:** **Now do you think it is a better way of communicating with students and your lecturers?**

**STUDENT:** Yes, for that short experience I think it was good and it was nice. And even if like you are in your room you can just get on into them and check what you want to check. Check the meetings, when are we meeting.

**ADDAM:** *And does it encourage or can you look at it from a negative side? Does it encourage absenteeism ,because you know definitely the lecturer's notes is going to put on the blackboard, the tasks that he will be giving, is going to be on blackboard. The exercises are going to be on the blackboard. So I can just get information and solve it there and then submits.*

**STUDENT:** Yes, it might encourage absenteeism, but although I may know what the lecture is doing in the lecture hall, but through my experience I realised that it is very important to be in the presence of the lecturer, because the way we hear the lectures is not the same and then if you are in the lecture room, you may come across something that you don't understand, but whereas others you

don't even recognise it. Then you will be able to ask. It is not the same as getting notes from someone who was in the lecture hall.

***ADDAM: How you use ICT's to facilitate lifelong learning?***

***STUDENT:*** Like sometimes on the internet you will find that there are certain problems that they pasted in mathematics, then you just become interested and you want to see where this guy is going to or what he is arriving at? Like I remember there was this problem, the lecturer presented us with it, only to find that usually most of the problems that they presented us, are in the textbook, but that one was not in any textbook and even the procedure to solve it, it was not in any textbook. Then you have to go to the internet and then you will only find somewhere else where they talk about it on line and that is when we came up with the way of solving it.

***ADDAM: Can you elaborate on how you used the projector to motivate your learning and at the same time to develop your interests and make learning fun?***

***STUDENT:*** One thing that I have realised coming to the projector, it is something that any experienced learners, unlike always coming to class with a chalk and stand at the chalk board. I remember when I went to the class during practise teaching I presented them with a video. Then it was so quite. They were listening and wanting to take notes, everything, and they even wanted me to come even when the period was over. Although learners may seem like that they are misbehaving when you are teaching at the chalk board, but something different it gives them a need to learn.

***ADDAM: What kind of ITC's do your lecturers currently use in their lectures?***

***STUDENT:*** Yes, the one that I remember, they used the laptop and the projectors like for MMAT 421. He presented us with the research reports of the previous students, because we were supposed to write a research report. He presented us with certain sections on the research reports that were written by the previous students.

***ADDAM: So it implies that even they don't use the ICT's to challenge your innovation creativity in other words?***

***STUDENT:*** Yes, the only case that they use it more often is to project notes for discussion.

***ADDAM: What challenges do you face using ICT's in you learning process.***

***STUDENT:*** Most of the websites are blocked, especially in the University. You don't access all the websites and sometimes you will find that our login details have a period of validity. After that period they expire and only when you go to the computer lab, when you are trying to log in, you will find out the pass word expired.

***ADDAM: How do you use ICT's to collaborate with peers?***

***STUDENT:*** I have never tried that before. The only one that I do is to invite my study mates for discussion. .

***ADDAM: And how effective was it?***

***STUDENT:*** Ja, it is effective like if you are having a problem, I am experiencing a difficulty with a problem, I just tell someone can you help me with this problem, because I don't see where, how am I going to get a solution and then he just say come and we will see.

***ADDAM: Okay, so you never discuss a problem using the ICT? You just communicate meetings.***

STUDENT: We just communicate meeting but discussing the problem physically

ADDAM: *Have you tried using ICT to evaluate your progress?*

STUDENT: I have never tried that before.

ADDAM: ***How do you evaluate the blackboard service and what recommendations would you give with your one year or one semester interaction with blackboard?***

STUDENT: Yes it is good; the problem is like not all of the students are covered. It is only a certain group that is well equipped with blackboard and some groups they are not even bothering at all. We just heard it before that there is going to be blackboard and after that it came, then we never heard anything from it anymore. Sometimes when you go to the computer lab the lab is closed and you find students logged on the computers and they are busy with it, but they never logged onto blackboard.

ADDAM: *My last question for you. How are you prepared for competent ICT use? How are you equipped?*

STUDENT: That one I am well equipped. Like laptop I have got videos, enough videos that I will use in my presentation of lessons and even projector in the school that I am intending to go, they have a projector and then I know that I will use it.

ADDAM: *Thanks very much for your cooperation. I really appreciate your presence here. Thanks so much.*

**END OF STUDENT INTERVIEW**

## APPENDIX J

### GUIDING INTERVIEW QUESTIONS (Lecturers)

#### PART A

This part has to do with clarification of issues raised in the questionnaire hence vary from participant to participant.

#### PART B

##### Questions

1. How do you incorporate ICTs in real world settings?
2. How you incorporate communication software in students learning programmes.
3. How do you use ICT's to provide effective, efficient and dynamic service which is geared towards student skill development?
4. How do you use digital devices to skill students?
5. How do you skill students so that they can monitor their progress as you teach?
6. How do you direct your students to tutorial sites or sites which have got tutorials?
7. Briefly tell me how you use the ICT for lifelong learning?
8. It seems that within our community, I am talking about the University community; we are a little bit resistant to ICT's. What suggestion or what advice would you give, or what encouragement would you give, or what change would you like to see to challenge lecturers to embrace ICT's into their teaching method?
9. Now what advice would you give to the Department, to be more precise DMSTE, for effective incorporation and efficient use of ICT's in initial teacher education?
10. If you were invited to speak at a conference about ICT's in teacher education, what would you say?

## APPENDIX K

### INTERVIEW DATA - LECTURER PARTICIPANTS

#### LECTURER CODED L1 BEGINS

DM650016 (L1)

ADDAM: *Welcome and I am very pleased to have you as one of my participants. I want to tell you that this interview is confidential. There will be no disclosure of the content, in any form to a third party. So you must be very much relaxed.*

LECTURER: Thank you.

ADDAM: *This discussion is going to be twofold. The first part has to do with in depth understanding of your response to some of the questions in the questionnaire and the second part is a further probing into your ICT knowledge and how you use ICT's to develop skills in your students and yourself and its influence on your teaching.*

ADDAM: ***How does the blackboard modify or change your approach of teaching? Has it in any way changed your approach to teaching?***

LECTURER: No, it has not changed my approach to teaching. It just simplifies things. You know, placing the notes or whatever information that I wish students to have, or maybe something that I missed, you know, it can be easily pasted on the blackboard and they can easily access for the fact that they have their e-mails linked to the system, and then it becomes accessible. So they can easily access that for the fact that they have e-mail addresses and they can access the internet very easy.

ADDAM: *Does it replace teaching or is it used as a supplementary to the teaching?*

LECTURER: For me it is a supplementary to traditional teaching.

ADDAM: *Does it also employ you to search for more information?*

LECTURER: It does. Believe me it does, because you know the students that we are teaching these days, they are not old fashioned like we are, to an extent that sometimes it annoys me that when you ask them a question 20 multiply by 10, they would quickly rush for their calculators but with us, we would know. When you ask them about definition of something they will quickly go for.., to Google. You know with us you would know the facts. You would know these definitions and so on. So for me it supports. You know it does not necessarily take over.

ADDAM: *Does it challenge your teaching?*

LECTURER: For the intelligent ones and the hardworking group it does, because they will seek for information and come with this problem questions and so it is more often that one has to be abreast of the group. You may take it that they use the Google for playing games and stuff, but with others, it is more than that, seeking for information.

ADDAM: *Does it make your teaching more progressive?*

LECTURER: And enriched, not only progressive.

ADDAM: ***You have information and pasted it on the blackboard. How do you make sure that there is conceptual understanding?***

**LECTURER:** Once I meet with them and I did for instance, suppose it is a new topic, I introduce the topic and explain, then from there refer them to the blackboard. Then you know it helps.

**ADDAM:** *But does it confirm that they do actually understand?*

**LECTURER:** Okay, you know one thing that I noticed with the students and the way that ICT helps is that they can communicate, seek for more information in case they did not understand they call me or just write an e-mail to say I did not understand this. Is it correct if I do it in this way and so on? And one thing that helps is that when they come with problems I want them to show me how they did it before, where did they go wrong, where they got stuck and we take it from there, but if they come blank then I don't attend to them.

**ADDAM:** *Do they seek for problems by themselves on the topic via the internet or via the said ICT systems or devices or you give them the problems to determine?*

**LECTURER:** I give them problems to seek for answers. Yes, as I said it will only be the hardworking ones that come with something new. What does it mean? Is it true? Has it been proven? And things like those.

**ADDAM:** *Okay now the blackboard system is it a 'cut and paste' system or is it a real system that develops children to understand or they also cut and paste?*

**LECTURER:** The 'cutting and pasting' comes when I have my notes. They are prepared on my system and I want to place them onto the blackboard. It is then that I use the cut and paste method. But otherwise then it is more than this. It is the best method. I don't know.

**ADDAM:** *Okay the reason why I am asking you the 'cut and paste' method is because if you have any tutorial material, you capture it and paste it there. If there are any assignments, you capture it and you paste. And when they finish, they also capture and paste it there.*

**LECTURER:** Yes. It is true.

**ADDAM:** *So is there any other way that they can easily go into the system where they can find something for themselves on the blackboard?*

**LECTURER:** Not to my knowledge.

**ADDAM:** *What about other ICT devices like cell phones, the internet, the computers, the data projectors and others that are digital or non-digital?*

**LECTURER:** Okay, now if you remember quite well on my response I said I don't use those often. Yes, I only send SMS's sometimes

**ADDAM:** *How do you use ICT to obtain curriculum resources? As lecturers I believe that we are supposed to be looking around, fishing all over the place for resources that will make our teaching interesting and easy for our learners to conceptualise. Now how do you use ICT's to obtain this resources? For example there are e-textbooks on the internet, tutorial materials and worksheets. How do you use ICTs to obtain such and how do you communicate that to your the students?*

**LECTURER:** With some of the books that I am using, for instance physics, it has some referrals to the internet where you can just go there and have an animation of what is happening with explanation. The interesting part is that they don't do calculations anymore and that is one thing that I like. They just explain in the form of animation and I think in that way it makes them simple. So I refer them to such things. And then one other interesting and difficult topic to conceptualise is nuclear physics where there is fusion of atomic nuclei. These are very difficult to conceptualise so with the animations it works out easy. I once requested the students to bring their laptops and it worked out very well.

***ADDAM: How often do you encourage them to bring laptops or use their cell phones to verify information, skill development and conceptual understanding enhancing approach?***

***LECTURER:*** With cell phones not very much. I want to be frank with you. The problem is that you will think they are busy with their academic work, whereas they are busy with their private things. So I prefer laptops.

***ADDAM: How do you engage sharing knowledge and experience with colleagues in a discussion forum or discussion group on the internet?***

***LECTURER:*** Yes, yes, i do a lot and with my colleagues. We discuss a lot about getting information from the internet and even guide which ones is strictly for which topic, if we are discussing the same topic.

***ADDAM: How does it challenge your academic growth? Self-development and translate to the student's development.***

***LECTURER:*** It requires me to seek deeper on a particular topic so that presenting it does not become a problem and you know sometimes students ask challenging questions. So to avoid feeling embarrassed, it is best to go deeper into that topic. It helps to go deeper to seek for more information so that when you discuss it and explain it to your colleagues you don't stumble.

***ADDAM: You mentioned that sometimes in your lecture periods, you advice the students to bring in their laptops, where difficult concepts can be easily observed in animation or simulation. It goes to help them actually understand what is happening with those topics that are difficult in the textbook. Now with that approach, do bringing ICT devices to lectures motivate innovation and creativity in your students and yourself using animation to conceptualise?***

***LECTURER:*** Yes, I think it does. You know lecturing only won't be effective and it won't make teaching interesting. I think it is important to use other things like bringing their laptops in and going through them and something that they like, you know, they are advanced, far advanced than I am when it comes to such devices. So it simplifies things for them, because it is something that they like. That is number one. Number two, it also motivates them to seek for more information to say okay this equipment can also be used for such things, you know, and not for playing games and playing music only and with that at the back of their minds they can also look for more information from other courses, modules and so on. It also motivates them to prepare for teaching during practice teaching.

***ADDAM: The social media has come to stay with us or has caught up with us. What I mean by social media is like whatsApps, the Facebook and the twitters and stuff like that. Do you find using the social media as a channel for academic development or academic work?***

***LECTURER:*** No, I have not. Except that I just send SMS's for this and that. But then for academic stuff no.

***ADDAM: How do you use the blackboard to monitor your students' progress?***

***LECTURER:*** You know I am in the mainstream and part time at education. So there are things that I do with my education students and there are things that I do with my main group. In some instances what I am doing with education students are different to what I am doing this side. And so that side it is where I use blackboard. Yes and that side there are things that I use that are not really blackboard. There is a way that I use to verify if they went through the system, if they went through the material, the tutorial. It shows you once... it indicates that so and so went through the material. You know and it becomes a challenge when and there is a time interval for that supposing this will be ready from this time to that time and if they don't go through the material during that period, it becomes blocked. So in one way or the other they just try to go through. You know, they do try to go through it.

***ADDAM: Discuss how you use ICT's to provide effective, efficient and dynamic service which is student skill development orientated apart from the blackboard.***

***LECTURER:*** You know I use ICT only for acquiring tutorials and questions and work sheets. For acquiring skills this is what I did, I took them out on a field trip. We took the first years out to Pretoria and Johannesburg where they had hands on; in other instances they were lectured too. So when you take them out, then they get specialist, people who specialise with those equipment and explain how they work and now they see a relationship between what you were learning and what actually happens in real life. I think whatever knowledge they gained on field trips somehow boosted their skills.

***ADDAM: Discuss how you sent students to websites or internet or ICT devices, to find information by themselves?***

***LECTURER:*** Many times. In other instances, instead of introducing them to it, I would request them to go for information on this topic and they give feedback .

***ADDAM: Explain how you use ICT's in your practice to facilitate students' lifelong learning?***

***LECTURER:*** I believe that with ICT they will remember that this is what we did. Seek for more information on topics in case we have challenges and definitely they will use it.

***ADDAM: How do you prepare your students for competent ICT use?***

***LECTURER:*** You will not be sure if they will be competent at the end of the day, the first step that I took is to request ICT section to offer help to and introduce blackboard to the students so that when I request them to check whatever is on the blackboard, they know how to do it. How to look for information? How to get information? How to relate and use the information retrieved and so on.

***ADDAM: How do you evaluate the blackboard service as a lecturer?***

***LECTURER:*** You know for the fact that it served me well this year, I think it is a good system. The only disadvantage, you know when it comes to tests, for multiple choice it is very good and the marking thereof, but when it comes to long questions, it becomes a problem in the sense that some of the students are not computer literate and to type answers in physics is full of calculations, then it becomes a challenge. So I think I will recommend to the ICT staff to introduce computer literacy.

***ADDAM: What changes would you like to see to encourage lecturers to embrace ICT's in their practice?***

***LECTURER:*** It is a bit difficult. You would realise or you may realise that a lot of staff members here are a bit old, in a sense that they are BBC's (born before computers). And you know for them to use blackboard they see it as a tedious process. They prefer their old way of doing things and that is an overhead projector and the likes and writing on the board. So it is going to be a little difficult, unless if the tutors are encouraged to attend these workshops, blackboard workshops.

***ADDAM: What advice would you give to the department (DMSTE), for effective incorporation and efficient use of ICT's in initial teacher education?***

***LECTURER:*** The advice that one can give will be for them to buy these equipment as we use them in our lecturing. The students are going to use them at their different schools and these are the things that are modern, like the computers, because it is something that they like and they enjoy when using it. It will be easy for them and who knows, it may even push them to work very hard to say oh, we are going to use this things instead of chalk and the board and so on to make presentations.

***ADDAM: If you were invited to speak at a conference about ICT's in teacher education, what would you say in just two sentences?***

***LECTURER:*** I would encourage teachers to use ICT, because we are not moving backwards. We are moving forward and ICT is here with us. Our children are computer literate and they enjoy it and they would love to see it being used. So it is our life. I would encourage that it be used effectively. Now that it is the wish of the government that all schools have computers, these computers should be utilised effectively for the students, especially those from rural areas.

***ADDAM:*** Alright, thanks very much.

***LECTURER:*** It is a pleasure.

### **END OF LECTURER 1**

### **LECTURER CODED L2 BEGINS**

***DM650017 (L2)***

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***ADDAM:*** Thank you for availing yourself for this discussion which is going to be in twofold. I would like to probe more about your response to the questionnaire and then secondly to dig a little more into your ITC background and how you apply ICT in your teaching and learning. So just be relaxed and be assured of absolute confidentiality.

***LECTURER:*** Okay

***ADDAM:*** Discuss the benefits of incorporated ICT in your curriculum delivery and your delivery of technology.

***LECTURER:*** Actually my approach to this realising that there are not enough resources in our teaching setup, what I normally do is I cut some slides for presentation in their class. So it enforces them to be participative too. What I do is I identify some websites for them to go and search for more information based on what we discussed in class.

***ADDAM:*** How do you use ICT's to obtain curriculum resources for your teaching and for your students learning?

***LECTURER:*** Yes, normally what happens is I access in developing my teaching resources. Use the internet, access the departmental policy documents. At the same time get the e-books on the content by using internet. So with that I am able to download, but when I realised that this is the job of the students, like accessing journals, articles from the journals, I just give them the journal name and they go and access it on their own.

***ADDAM:*** Sharing your knowledge and experience with colleagues in a discussion forum or discussion group on the internet as a way of teambuilding. Explain how this influences the progress of your curriculum delivery

***LECTURER:*** Actually what I can say is that in most cases we don't have such forums within and the skills that I get was the time I was a student, because we would get the tutorial that will help you, self-propel you to seek information on your own and that was so useful.

***ADDAM:*** Discuss how do you incorporate tutorial software in your students learning program?

***LECTURER:*** The whole University community students are using computers that are based in the Maths building and within the School of Education, you will find that there are three or four labs and our numbers are huge. You give them a

task to go and search for information on the internet or you load the stuff on blackboard for them to find on their own so that you can control, you find that it becomes difficult for students. And hence you find that most of the students are buying laptops, and of which others can't afford to get those laptops. So it becomes a futile exercise.

**ADDAM:** *Now while I talk about tutorial software, not necessarily buying software that you can use to generate tutorial. Now you referred them to sites that they can easily get tutorials and practise to advance their learning or to make your teaching more flexible, for them to assess knowledge from other sources, which could help their progress.*

**LECTURER:** Yes, normally I give them, like sometimes I give them the stuff about .com (search engine) and then there are sites that give a lot of information concerning technology lessons and some technology equipment. I do that but it becomes difficult to access some of this information, because of the problems that I have just explained. But with Wi-Fi installed in the laboratories it is becoming much easier, because we are now encouraging them to buy laptops, to bring them in class, so that sometimes we can refer then to you tube to get some other live information, about some of the things that they are doing.

**ADDAM:** ***How do you use ICT's to present information to develop your students' skills? How do you use it to present information and by so doing by developing skills in your students?***

**LECTURER:** Normally during method subjects, it is where we teach them how to use ICT by cutting the power point presentations that they present in class and in that case it enhances skills for them to use this equipment.

**ADDAM:** ***How do you encourage your students to use the social media as an academic tool like the WhatsApp they have, the Facebook they have? Do you encourage them to use that as an academic tool where there will be collaborative learning and corporative learning?***

**LECTURER:** No, that has not come to my mind yet.

**ADDAM:** *The ICT concept is not catching up well with most of us, because I think some of us are being born before computers emerged. So as a technology lecturer, **what suggestions will you give for successful implementation of ICT in teaching and learning?***

**LECTURER:** The suggestion I normally give, more especially to my students, is that a person is taught basics in technology and build on to meet the demands of the changing technology. We need to acquaint ourselves with what is happening. Like I said to them each one should buy his or her own computer and the best teacher of a computer is a person him or herself.

**ADDAM:** ***How do use ICT's to develop your creativity and innovation and those of your students?***

**LECTURER:** Actually when I give my presentation I make sure that it is colourful to get some of the designs that are there in the computer just to help my presentation attractive to them and this animation stuff, this thing of hyber linking stuff, you will find that you have an idea, but there are some ideas around it. You would present an idea and then press one by one to express the ideas that are around that big idea. So in that case it becomes so interesting and it enhances and encourages students to do the same.

**ADDAM:** *How do you encourage your students to do likewise?*

**LECTURER:** I do tell them, but the problem is resources and they don't get enough time to come and sit down with me to get more skills about those things, because they are occupied with other programs.

**ADDAM:** *Alright, **what advice would you give to the department, (DMSTE) for effective incorporation and efficient use of ICT's in initial teacher education?***

LECTURER: The Department should reduce the number of modules that the students do and let them be focussed on their specialisations. Number two, let's incorporate ICT in all our teaching and planning and create environments in our teaching which will encourage the use of ICTs in teaching and learning.

One other suggestion is that ICT can be regarded as a compulsory subject or module up to the last year of study. I think that would assist students to gain more skills that are required especially in the method subjects. Unlike at present they take it as an elective module. A fundamental module for one year and it is over.

ADDAM: *Now my last question, if you are invited to speak at a conference about ICT's in teacher education, what would you say?*

LECTURER: It is quite a difficult question. But what I would tell them is that ICT is the way of teaching in our future, because all those things that we are doing, like you can check here, people are still using chalkboards and this stuff. Those things are outdated. So the backbone of teaching, the way of teaching in this 21<sup>st</sup> century is via ICT.

ADDAM: *Alright, thanks so much. I really appreciate your contribution.*

LECTURER: You are welcome.

### LECTURER L2 ENDS

### LECTURE CODED L3 BEGINS

**DM650018** (L3)

ADDAM: *Good morning.*

LECTURER: Good morning.

ADDAM: *And it is a pleasure to have a chat with you. I believe that I am going to get a lot of knowledge and insight from you regarding what I am doing and I just want to thank you so much for opening your doors for this interview.*

LECTURER: Okay, thanks so much.

ADDAM: *I want to say that I know they say walls have got ears, but I believe these walls don't have ears at this particular moment in time. I assure that there is confidentially.*

LECTURER: Hopefully there are no spy tapes here.

ADDAM: *What I am to discuss here is purely for my academic work so please feel free, relaxed and open up to me as much as you can.*

LECTURER: Okay.

ADDAM: *The interview is going to be twofold. The first one is to probe a little more into your response to the questionnaire and the second part would be to further find out more about your ICT background, ICT implementation, ICT knowledge.*

LECTURER: Okay.

ADDAM: *Now one question which I need elaboration: **discuss how you incorporate tutorial software in your students in learning and you said you never used it.***

LECTURER: Yes, you see generally in terms of ICT one of the things that we use to allow students to access blackboard, e-mails and the internet. But in terms of tutorial software, I do not have any tutorial software. But I know there are many

different kinds of tutorial software that you can actually be able to access, but unfortunately my teaching and learning with my students, we don't use anything other than the internet or the e-mail or the blackboard.

**ADDAM:** Okay.

**LECTURER:** The other day I was looking at a website called SAS curriculum and that particular websites says if you want to register you have access to many different kinds of software that you can actually use. There is another one that I use on an i-pad called Kind has many videos and learning materials that you can actually access. But I have not used in my class, though I have been able to access the website. Secondly, the modules that I teach don't lend themselves to be using tutorial software, because most of the time I am dealing with how I teach a particular content. Therefore it does not lend itself to that aspect.

**ADDAM:** *What advice would you give to your student in that context? Because I believe that you are producing students to go into the world and they have got to get familiar with technology. So if you don't use it, does it mean that you don't refer your students to sites that they can access tutorial software?*

**LECTURER:** I think with blackboard, one of the things that it would help us to do, is be able to get students to identify different kinds of resources that they can use in the classroom because as teachers they should be able to use technology. Taking the example of the Kind Academy website, you can actually download this thing free and use in the classroom. So it is something that I want to try and implement. Just to make sure they familiarise themselves with this software. Also, there is much open software they can access. Open source is the direction many people are going to now. I think these are the kind of things that maybe I have to expose them to more

**ADDAM:** *Now in your response, there is a lot of emphasise on your technical skill acquisitions or should I say development? How do you transfer your technical skills to your students?*

**LECTURER:** You see one of the things that I try to do with my students is to encourage them that learning should not stop and technical things can enhance your teaching and if it can enhance your teaching then you should not be afraid to want to learn a little more about them. Sometimes, I take i-pad to the class and demonstrate how it could enhance conceptualisation. For example, we were able access You Tube; say a video that talks about the first ten elements of the periodic table which was put in a form of a song to facilitate learning. This is one way of getting them to use technology to enhance their creativity of lessons. So that is how you translate it to your students, by also demonstrating yourself and trying to bring in different things into the classroom.

**ADDAM:** *Now with this skill of creativity and innovation that you have just talked about, which of these do you normally demonstrate in your class, how do you encourage the students to embark upon such by letting them take responsibility and take practise of what you have just talked about?*

**LECTURER:** Many times they do presentations and I give comments or feedback say I think one of the things that you can do, maybe is to think about this aspect, which was silent in your presentation. That sort of helps them and encourages them. We had a presentation on that other day and when they used for example the power point I was surprised as to how they were able to use the animations in their presentations. So it means that they know the tools that are there and they know that it can be used to enhance their presentations.

**ADDAM:** *Now let's move on to your ICT knowledge how it impact on your practice and how it affects the students. How do you use ICT for lifelong learning which enacts on your students?*

**LECTURER:** When I talk about for example to them about matter, I referred them to a website. Referring them to that particular website automatically encourages them and say okay if you get to this particular website this is what you are able to do. It means consulting internet can provide further information on what they want to know.

***ADDAM: How do you evaluate the blackboard service?***

***LECTURER:*** It is difficult for me to put a rating on the service however; I think that is the direction for us to go.

***ADDAM: How would you encourage your fellows or your colleagues to be more involved in ICT which eventually translate into developing skills in the students?***

***LECTURER:*** I think what is important is for us as teachers, is we must be able to say, using technology, is it possible for it to enhance what I do in the classroom? Today we will only use the chalkboard and all your life you are only going to use the chalkboard. Can you imagine while you are busy writing on the chalkboard the learner that is in your class or the student in your class is busy accessing the internet, he has got all the information in the palm of his hand and you are still busy writing on the chalkboard. I think that does not make any sense and for us as teachers if we don't have the desire to want to go to the next level. It means you have to examine what route will take you there and if the route of ICT will take you there, you have to embrace it and improve on what you do in the classroom. Every time as teachers we have to reflect on what we do.

***ADDAM: How do you use ICT as a lecturer for conceptual development and how do you encourage your students also to use ICT's for conceptual understanding?***

***LECTURER:*** Yes, one of the things that is important for us is that we want to teach for conceptual understanding. And you see the way I would want to look at it, you see if I use ICT the content knowledge that I would gain from ICT, improves my theoretical understanding. The content knowledge that you get is not only from one particular source, but from many different sources and will confirm the kind of information that you require. When you teach for conceptual understanding it is to ensure that the person has the correct theoretical foundation and I think using ICT helps to create that theoretical foundation that is necessary for the student because when you teach for conceptual understanding, it is important as a teacher to know in detail the content to be covered and this is the knowledge that the student would require.

***ADDAM: Now with that being said, that you have this theoretical foundation being developed, now how does that help the student as well to develop that theoretical foundation? Or you have used it to develop your theoretical foundation and building on that for conceptual understanding.***

***LECTURER:*** Yes.

***ADDAM: Now how did you use that at the same time to help the students to develop that conceptual and theoretical...?***

***LECTURER:*** I mentioned fracking, as an issue, which is currently happening in the Karoo in terms gas exploration, for discussion and presentation, I was amazed at the kind of information that they were able to bring across. Now I did not tell them what fracking was but what happened was that they went and researched for themselves. They found out the relevant bits of information. They found out the pro's and the cons themselves, and were able to present the information. So that particular student that started off knowing absolutely nothing about fracking can now enlighten you based on what they have learned. So I think that is how we try and make sure that students learn and they improve their content and theoretical knowledge.

***ADDAM: So you taught them to face challenges and research into it?***

***LECTURER:*** Yes.

**ADDAM:** *And they worked around the challenge to develop that theoretical background and conceptual understanding of what they wanted to know.*

**LECTURER:** Yes.

**ADDAM:** *What suggestion would you give to the Department of Maths, Science and Technology Education for effective incorporation and efficient use of ICT's in initial teacher education?*

**LECTURER:** I think my advice would be simple. I think that all of us, simply we need to embrace it number one. Number two, in keeping up with the times, I think it is important that by using technology we can expose learners to a vast of information. Also I think what is important is the following; you know one of the things that we also learn to do, as managers, is to conserve the environment. So if we go the electronic route it can also help us to be able to conserve the environment in a way. So in other words by placing lots of information on the blackboard, you have students that are able to access information. You know one of the things happening to us now is that we have large classes and a lot of marking to do, and yet you can give the student an assessment on blackboard and the student can get an instant feedback.

Many of us are traditional and believe the classroom, is where I teach, so we don't allow for phone discussions or debates to take place in an open space environment. And I think that with technology it allows students to talk to each other. Not only in the confines of the classroom, but in a different environment. So they could be relaxed in their room and they are texting each other or maybe they are able to access information and they are able to do that.

**ADDAM:** *How do you encourage your students to use the social network for academic discussion forum?*

**LECTURER:** The use of social media is not something that I mean many people have embraced. And I think that it is not an easy place to go, because on the social media platform, the only thing that you are talking about is social issues. Social media it is something that is relatively new, especially to use in terms of the classroom or even a simple thing like a cell phone, because most of the students do their assignment on social media and on cell phones. And they were very sceptical about using it in the classroom.

**ADDAM:** *Now if you were invited to speak at a conference about ICT's in teacher education, what would you say in summary?*

**LECTURER:** Life is such that we are always changing and we are always evolving. And one of the key things that I think I want to say and that I want to encourage people to change. The technology that is there, we must use the tools to advance our lives. Why is the technology created? It is created to make our lives easier to get information at our finger tips. If I am looking for something, I need to go look through volumes and volumes of encyclopaedia to get the information. Yet today I am able to get that same information right at the touch of a bottom. How do I use technology so that it can enhance my teaching? And our children have grown up in a technological world and they are used to these technology gadgets like the computers and others. So bringing technology to your lesson will automatically place them in their where feel comfortable. And because of that they would want to learn more. So I would talk about change and how to incorporate and bring ICT to enhance the teaching and learning.

**ADDAM:** Okay, thanks very much.

**LECTURER:** No, it's a pleasure.

**LECTURER L3 ENDS**

## **LECTURER CODED L4 BEGINS**

**DM650019**

**(L4)**

**ADDAM:** *Good afternoon. Thank you very much for availing yourself for this interview. I want to assure you of absolute confidentiality. So please be very free and chat with me for the next few minutes.*

**LECTURER:** Okay

**ADDAM:** ***How do you incorporate ICTs in real world settings?** The question has to do with when you are teaching technology for example, how do you use ICT's to locate settings which are real and you can relate those settings into the real world environment. Let's say I am teaching about crankshaft or teaching about a building structure, I can use ICT to rotate this structure in various dimensions for the students to see it. Then when they get into the field of practice it does not become very new to them, because they have seen the model orientated at different positions for them to see what you are talking about. Not only just using the two dimensions as you see this is a crankshaft. How do you employ that in your teaching?*

**LECTURER:** Yes, I must emphasise that we teaching technology, and then when I teach mechanical technology, for instance if I talk about an engine which students have never seen before, what I normally do is after the video that I have presented in class, I will bring them to my office, then you go to the relevant sites that demonstrate the application of the engine and all those, which they find interesting, because they see it actually happening and they can see the process. In that way the ICT compliments what I did in class, yes, and the emphasis of that, even students on their own, they can go and explore this further in the computer laboratory or on their own personal computers.

**ADDAM:** ***How you incorporate communication software in students learning programs.** And what I mean by communication software could be e-mails, chat discussion forums, social media. How do you use those in student learning, chatting with the students, sending them sites to go and find out more about the topic that you have been given or you have dealt with? How do you use this communication software to advance teaching and learning?*

**LECTURER:** That is one area where I have got limitations. I don't use that, but my communication with students is around SMS's. For instance if I want to give a task, I will use the class representative; send an SMS to the him/her to communicate that with the other students. As of the social media, whatsApps and e-mail, I am not using those, but I don't sort of nullify them, because they can be used as tools to establish the linkage or to build a linkage between me and students, whereby if they see anything new in relation to the subject, they are able to share with me and even amongst themselves.

**ADDAM:** ***How do you use ICT's to provide effective, efficient and dynamic service which is geared towards student skill development?***

**LECTURER:** I am sort of a traditionalist. I am using the overhead projector, whereby I have got transparency and I just put them on the overhead projector and then project them to the screen. I think as the students have seen me doing it and sort of simplify the presentation, definitely they can use that, because my take on what influence students is what they have seen in class. It is what they have seen the lecturer doing. So if I use presentations probably they will do that and again I recall there was a time I went to attend the.., I was assisting in maths. I went to see a student and he had a power presentation ready. He brought his own laptop and he had the screen. He was just doing it beautifully. So because there are other aspects or some other concept that can be better explained when you have them in.

**ADDAM:** ***How do you use digital devices to skill students?***

**LECTURER:** As we are about to migrate to the new building, yes I have got plans, because I, teacher technology, if there is a concept or there is a certain

technique that has been applied which is not understood by students, if my lab is resourced in such a way that we can search that from the internet on the spot, then I will say ja we are into this, because whatever argument you may have, you can easily just go into the internet and then access it and then that on its own will sort of bring in some critical thinking skills, because students will be able to interpret on the same and they will sort of share their experiences and add value.

***ADDAM:*** *We are trying to produce teachers to make sure that before they exit the system, they can apply basic principles and basic skills in their field of work. So we are preparing them for the world in one way or the other. Now can you advice how we can prepare this students for the world of work?*

***LECTURER:*** *It is about firstly exposing them to a lot of strategies that they may apply. If we get them exposed to ICTs for instance before they leave the system, they will be able to make presentations on power point. The good thing about having your presentations electronic is that you are able to make changes easily on them and you can even update them, if need be, so you don't struggle, because they are there in the system.*

***ADDAM:*** *How do you skill students so that they can monitor their progress as you teach?*

***LECTURER:*** *I think one area one can explore is micro teaching in the sense that there should be micro teaching laboratories fully equipment. The video cameras, the audio video facilities, so that the students as they present, they are being recorded. Then later on you play back the tape so that they see how they made the presentation and at the same time you allow other students to comment on the presentation. So it is like it will enhance student presentation skills.*

***ADDAM:*** *How do you direct your students to tutorial sites or sites which have got tutorials?*

***LECTURER:*** *We don't have that. Currently I do not have tutorials that I give to students. But now that you have mentioned it I must start exploring other tutorials which will enhance the students' learning.*

***ADDAM:*** *Now can you briefly tell me how you use the ICT for lifelong learning?*

***LECTURER:*** *If you can get to a point whereby students are able or even the community or the people are able to buy for instance i-pad and then whatever your topic, the sources they can download there and read about those. It is like maybe it will get to a point whereby many people will be reading books electronically. The e-books and ja, to themselves, because the good thing about the electronic, is that at your space you can just open and you don't need to have luggage. For instance you are at the airport. You are buying time. You still have got an hour waiting for your flight. You can just go through that book and the good thing is that some books already they have got this audio equipment. So you can just plug it into your ear and then just listen while waiting for your next move.*

***ADDAM:*** *Now in other words it seems that within our community, I am talking about the University community, we are a little bit resistant to ICT's. What suggestion or what advice would you give, or what encouragement would you give, or what change would you like to see to challenge lecturers to embrace ICT's into their teaching method?*

***LECTURER:*** *I think it is to start with the resources we have in our classrooms. If we may have ready-made power points facilities, then as we teach, we must teach them how to use the facility as well. If we give students an assignment which needs presentation, then we encourage that they do the same that will sort of instil the culture of ICT.*

***ADDAM: Now what advice would you give to the Department, to be more precise DMSTE , for effective incorporation and efficient use of ICT's in initial teacher education?***

***LECTURER:*** Firstly you will start with the..., because the kind of students we are getting, they probably have limitations on computer literacy. We can start encouraging that number one they type their assignments. Number two, whenever there is a group assignment or any group presentation; it must be done in the form of some electronic means.

***ADDAM: Alright, my last question is if you were invited to speak at a conference about ICT's in teacher education, what would you say?***

***LECTURER:*** No I will definitely promote ICT. The reason being or let me say this, some people are saying the kind of generation we have now, they don't like reading and that is a myth, because when we read the SMS's, we read the whatsApp, we spend more time reading. Okay. That is one area that I think we may explore. Maybe people are no longer finding interest in the book, but what if electronic, they can read it and we may have some books being converted into the audio.. So you plug in, you listen.

***ADDAM: Thanks very much for the opportunity that I have had with you. It has been so beneficial, thought provoking, highly motivational and inspiring. I am very grateful. Thanks.***

***LECTURER:*** I am glad I was able to do that.

***ADDAM: Do you have any comment to make? ?***

***LECTURER:*** No,

**END OF LECTURERS INTERVIEW**

## IT STAFF – EDUCATION TECHNOLOGIST

DM650020

ADDAM: *Thanks for giving me this opportunity to have a chat with you. I want to assure you of absolute confidentiality. So be free to tell me whatever you feel appropriate.*

IT1: Alright.

ADDAM: *The interview will be twofold. First part is a follow up to the questionnaire. The second part is to probe a little more into the blackboard system in the University.*

IT1: Okay.

ADDAM: *The questionnaire was well answered and very clear so let me go straight into further probing. As IT educational technologist, **how do you see the beneficiaries (students and lecturers) of the blackboard system value the system?***

IT1: So far the take from the students and the instructors, (the academics, the lecturers) is so positive in such a way that most of the students are on Blackboard. They find it handy to work on it, because they just get material and in a very short time and the revision thereof, they always get their revision notes any time they want, because immediately after the lecturing or before the lecturing, they always find the materials on line. They can go anywhere, any time to read it. So it is positive attitude really from them and they are doing well so far.

ADDAM: ***How you get the students involved in the program?***

IT1: To get the student involved! We don't basically find any hiccup, because to get the student involved enough we get the lecturers involved. So if the instructor the lecturers involved, then automatically the student will abide by their rules. If you start to use the blackboard as a student, you must be attached to that. Otherwise it is a different way of getting them involved, because immediately after I managed to convince one lecture and he uses the management system with his group or a group of students, those group of students will be able to tell their friends. The problem is to get the lecturers to use the blackboard.

ADDAM: ***Do you equip the students to use the facilities or you equip the students through the lectures?***

IT1: We equip them through the lectures. Immediately after we get the lecture to use blackboard, we then request for the student class list, so that we can be able to read the students on the system, before they can even use it. We go to the class and show them how it works, but most of the time you will find that they are far ahead of us. They know how to use it. The students are amazing. So that is the positive side of it. They don't take much time in order to understand it.

ADDAM: ***How do you motivate all lecturers to get involved and change their perception on technology?***

IT 1: To motivate them, we will be running some workshops and the instructors for these workshops will be the lecturers who already know how to use it. We don't want to take over the classroom. We want them to show their colleagues that this thing is good. So we have a couple of them who are using it, and then they are using it properly. They can even create some of the things that the system did not come with.

ADDAM: *Now do you have any plans of extending it beyond the University community? For example if I should be in Jo'burg and have a laptop, I can communicate with my students?*

IT 1: No, it is not specifically intranet. It is internet. It goes outside the boundary of the University. The only thing, the positive one, is that because it is the server that is local, the internet is down here, unfortunately you won't be able to connect to the server when you are outside the campus, but if the internet is up and the network is clear you can connect with whomever, in UK, wherever you are and communicate with your students. It is truly internet based.

***ADDAM: Interacting with lecturers and with students and from their reaction, have you observed whether the blackboard service has changed lecturers approach to teaching?***

IT 1: Yes, when we do induction for lecturers we normally encourage and teach them how to use the blackboard. We also show them how to prepare presentation slides. We always encourage them to teach with a plan, because on blackboard you cannot just put material without planning. This allows the students to interpret their lecturers. They are able to discuss and interact with their students more effectively and even amongst themselves in discussion groups. So I think that is the better thing about it so far.

***ADDAM: And the last but one question what type of feedback do you get from the beneficiaries of the blackboard system?***

IT 1: The feedback is always positive. Those who use it on daily basis tell you it is so handy and very helpful and that they cannot work without it. Students tell us this is very good. You know our lecturer will always tell us that you know, you have to write a quiz and you will find that the quiz, the feedback of the quiz come maybe after three weeks and then you are about to write the test. You don't know how you did in that quiz, but on blackboard, after doing a quiz, you get the feedback. You get even the results. So it is handy.

***ADDAM: Now how do you see the future of blackboard?***

IT 1: It is looking bright and as you know technology is evolving on a daily basis. In the near future, we are looking forward to the mobile where the student can be able to see the content on their cell phones. They don't have to rush to the lab. Wherever they are, if they are having the handset, they can just.., as long as it is a student at the University of Limpopo, they can just locate the icon of blackboard and click it and it will open. They will be able to see all the courses that are registered. Whatever course that has got material; you will go into content and see whatever was happening in class and so on. You can be able to discuss with the lecturers through the cell phone.

***ADDAM: Thanks very much. Do you have any other comments to make?***

**LECTURER**: No. You are welcome.

## APPENDIX L

### ACTIVITY SCHEDULE

<b>DATE</b>	<b>ACTIVITY</b>	<b>REMARKS</b>
August 2012	Questionnaire distribution	
August 1012	Collection of questionnaire	
October 2012	Interview with students	
November 2012	Interview with lecturers	
November 2012	Interview with IT staff	

## **APPENDIX M**

### **Title of the study**

Integrating Information Communication and Technology (ICT) in teaching and learning: The case of Mathematics, Science and Technology Education

### **LETTER OF CONSENT**

#### **Questionnaire for Students**

#### **Time Period**

**August 2012**

#### **Instrument 1S**

Dear Student,

I am seeking your permission to interview you on the above topic in relation to your integration of ICTs into your learning process. Please understand that your participation in this research is absolutely voluntary and you have the right to withdraw at any time. Your responses will be kept strictly confidential and used for academic purposes only. There is no wrong or correct answers to any of the questions as such feel free to express yourself to the best of your knowledge.

I shall return on \_\_\_\_\_ to collect the completed questionnaire.

Yours sincerely

*Billey Addam*

## **APPENDIX N**

### **Title of the study**

Integrating Information Communication and Technology (ICT) in teaching and learning: The case of Mathematics, Science and Technology Education

### **LETTER OF CONSENT**

#### **Questionnaire for Lecturers**

#### **Time Period**

**August 2012**

#### **Instrument 1L**

Dear Lecturer,

I am seeking your permission to interview you on the above topic in relation to your integration of ICTs into your professional practice. Please understand that your participation in this research is absolutely voluntary and you have the right to withdraw at any time. Your responses will be kept strictly confidential and used for academic purposes only. There is no wrong or correct answers to any of the questions as such feel free to express yourself to the best of your knowledge.

I shall return on \_\_\_\_\_ to collect the completed questionnaire.

Yours sincerely

*Billey Addam*

## **APPENDIX P**

### **Title of the study**

Integrating Information Communication and Technology (ICT) in teaching and learning: The case of Mathematics, Science and Technology Education

### **LETTER OF CONSENT**

#### **Questionnaire for Education Technologist**

#### **Time Period**

**August 2012**

#### **Instrument 1T**

Dear Colleague,

I am seeking your permission to interview you on the above topic in relation to your integration of ICTs into your professional practice. Please understand that your participation in this research is absolutely voluntary and you have the right to withdraw at any time. Your responses will be kept strictly confidential and used for academic purposes only. There is no wrong or correct answers to any of the questions as such feel free to express yourself to the best of your knowledge.

I shall return on \_\_\_\_\_ to collect the completed questionnaire.

Yours sincerely

*Billey Addam*

## **APPENDIX Q**

### **Title of the study**

Integrating Information Communication and Technology (ICT) in teaching and learning: The case of Mathematics, Science and Technology Education

### **CONSENT FORM**

### **INTERVIEW for Students/ Lecturers/Technologist**

#### **Time Period**

**September / October 2012**

#### **Instrument 1S/L/T**

Dear Participants,

Thanks for volunteering to help undertake this research. Please note the following.

#### **Purpose of the interview**

The purpose of this interview is twofold. As a follow-up to issues that arose from the questionnaire which clarification and secondly to probe further into your ICT experience in teaching and learning.

#### **Guarantees**

I will conform to the ethical issues of research. This implies that under no circumstance will purposefully engage in any act that will expose your identity or information to a third party.

*Confidentiality:* All necessary steps will be taken to any information provided absolutely confidential. As such feel free and share your experience with me.

*Anonymity:* I will be using a tape recorder, however your personal details will not be required as such your identity will be protected.

## Consent Form

Please read the consent form carefully and respond. I will come around and collect the form and we will negotiate the date for the interview,



University of Fort Hare  
*Together in Excellence*

### Ethics Research Confidentiality and Informed Consent Form

#### Please note:

**This form is to be completed by the researcher(s) as well as by the interviewee before the commencement of the research. Copies of the signed form must be filed and kept on record**

#### **(To be adapted for individual circumstances/needs)**

Our University of Fort Hare / Department is asking people from your community / sample / group to answer some questions, which we hope will benefit your community and possibly other communities in the future.

The University of Fort Hare / Department/ organization is conducting research regarding ..... We are interested in finding out more about ..... We are carrying out this research to help ..... (*adapt for individual projects*)

Please understand that you are not being forced to take part in this study and the choice whether to participate or not is yours alone. However, we would really appreciate it if you do share your thoughts with us. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

I will not be recording your name anywhere on the questionnaire and no one will be able to link you to the answers you give. Only the researchers will have access to the unlinked information. The information will remain confidential and there will be no "come-backs" from the answers you give.

The interview will last around (X?) minutes (*this is to be tested through a pilot*). I will be asking you a questions and ask that you are as open and honest as possible in answering these questions. Some questions may be of a personal and/or sensitive nature. I will be asking some questions that you may not have thought about before, and which also involve thinking about the past or the future. We know that you cannot be absolutely certain about

the answers to these questions but we ask that you try to think about these questions. When it comes to answering questions there are no right and wrong answers. When we ask questions about the future we are not interested in what you think the best thing would be to do, but what you think would actually happen. (*adapt for individual circumstances*)

If possible, our organisation would like to come back to this area once we have completed our study to inform you and your community of what the results are and discuss our findings and proposals around the research and what this means for people in this area.

### **INFORMED CONSENT**

I hereby agree to participate in research regarding ..... I understand that I am participating freely and without being forced in any way to do so. I also understand that I can stop this interview at any point should I not want to continue and that this decision will not in any way affect me negatively.

I understand that this is a research project whose purpose is not necessarily to benefit me personally.

I have received the telephone number of a person to contact should I need to speak about any issues which may arise in this interview.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to my community on the results of the completed research.

.....  
**Signature of participant**

**Date:**.....

I hereby agree to the tape recording of my participation in the study

.....  
**Signature of participant**

**Date:**.....

**OFFICE OF THE DEPUTY VICE-CHANCELLOR:  
ACADEMIC AFFAIRS**  
Private Bag X1314, Alice 5700  
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Fax: +27 (0) 86 628 2944  
[tsnyders@ufh.ac.za](mailto:tsnyders@ufh.ac.za)



## **ETHICAL CLEARANCE CERTIFICATE**

Certificate Reference Number: MTO02 1SADD01

Project title: Integration of Information and Communication Technologies pedagogy in Initial Teacher Education curriculum: A case study in a Higher Education institution in South Africa

Nature of Project: PhD

Principal Researcher: Billey Bright Addam

Supervisor: Professor X Mtose

Co-Supervisor:

On behalf of the University of Fort Hare's Research Ethics Committee (UREC) I hereby give ethical approval in respect of the undertakings contained in the above-mentioned project and research instrument(s). Should any other instruments be used, these require separate authorization. The Researcher may therefore commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the UREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the document
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

The Principal Researcher must report to the UREC in the prescribe format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

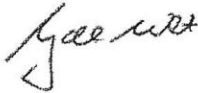
The UREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if

- Any unethical principles or practices are revealed or suspected
  - Relevant information has been withheld or misrepresented
  - Regulatory changes of whatsoever nature so require
  - The conditions contained in this Certificate have not been adhered to
- Request access to any information or data at any time during the course or after completion of the project

The Ethics Committee wishes you well in your research.

Yours sincerely



Prof Gideon de Wet  
Dean of Research

3 October 2012