

**Mathematics teacher-students' attitude towards Information and
Communication Technology across three countries**

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Mathematics teacher-students' attitude towards Information and Communication Technology across three countries

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Abstract

Low achievement in Mathematics is a problem that faces schools, colleges and universities, not only in South Africa, but worldwide. Many efforts have been made to explore different ways in which teaching and learning can be more effective. ICT provides endless possibilities to enhance the teaching and learning of Mathematics. The purpose of this study is to determine teacher-students' attitude towards ICTs in order to plan for effective, efficient and appropriate methods of Mathematics education. It further aims to determine to what extent these students will be willing to use ICTs in their own studies as well as in the teaching process in their classrooms, and aims to compare the students' attitudes across three countries i.e. South Africa, Tanzania and Finland. The population consisted of Mathematics education teacher-students enrolled at the following institutions: School for Continuing Teacher Education (SCTE) at the North-West University in South Africa (317 students), the Iringa University College, University of Tumbani in Tanzania (111 students), and the University of Joensuu in Finland (56 students). This study followed a quantitative cross-sectional survey design comprising a single mode research questionnaire to three groups of students in three countries. The instrument that was used was based on the Loyd and Gressard Computer Attitude Survey (1984) (CAS), with a few additional questions to add to the relevance of this study. Questionnaires were completed by each group of students. The questionnaires were posted to each Mathematics teacher-student at the SCTE with a return envelope included. The researcher visited Tanzania and administered the questionnaire to the students at their university and some students in Finland completed the survey online while others completed a paper-based copy, which was returned to the researcher. Descriptive statistical techniques, reliability and validity of the instrument scale, inferential statistics (ANOVA), and cross-tabulations were used, and where appropriate, effect sizes were calculated. Findings indicated that the teacher-students have a positive attitude to computers and that they are willing to use ICTs in their own studies and in their teaching at school. The comparison of their attitudes revealed that the South African and Tanzanian teacher-students have a more positive attitude towards ICTs than the Finnish students. The teacher-students in the two African countries were also more willing to use ICTs than the students in Finland, despite their increased exposure and access to technology. To create an environment of effective Mathematics education, a number of factors play an important role. Mathematics education supported by good pedagogical content knowledge can be transformed into effective Mathematics education with the aid of a positive computer attitude and willingness to use technology. Together these aspects are supported by the technological pedagogical content knowledge (TPCK) framework.

Keywords

Mathematics education

Computer attitude

Loyd and Gressard Computer Attitude Survey (CAS)

Attitude towards ICT

Mathematics attitude

Comparative study

Teacher-students

Quantitative analysis

Information and Communication Technology

Higher Education

Opsomming

Swak prestasie in Wiskunde is 'n probleem wat skole, kolleges en universiteite wêreldwyd trotseer. Verskillende wyses is vroeër ondersoek om leer en onderrig meer effektief te maak. Inligting- en kommunikasietegnologie (IKT) bied verskeie moontlikhede om leer en onderrig van Wiskunde te verbeter. Die doel van hierdie studie was om die onderwyser-student se rekenaarhouding teenoor IKT te bepaal om sodoende vir doeltreffende, effektiewe en toepaslike Wiskunde onderrigmetodes te beplan. 'n Verdere doel was om te bepaal in hoe 'n mate hierdie onderwyser-studente bereid sou wees om IKT in hulle eie studies en in hul Wiskundeklasse, asook hulle houdings jeens rekenaars te vergelyk met onderwyser-studente in twee ander lande (Tanzanië en Finland). Die studiepopulasie het bestaan uit Wiskunde onderrig onderwyser-studente geregistreer by: die Skool vir Voortgesette Onderwysersopleiding (SVO) van die Noordwes Universiteit (317 studente), die Iringa Universiteit Kollege, Universiteit van Tumbani in Tanzanië (111 studente), en die Universiteit van Joensuu in Finland (56 studente). Hierdie studie het 'n kwantitatiewe kruissnitopname-ontwerp gevolg, bestaande uit 'n enkelmodus navorsingsvraelys versprei na drie groepe studente in drie lande. Die instrument wat gebruik is, was gebaseer op die *Loyd en Gressard Computer Attitude Survey (1984) (CAS)*, met die byvoeging van addisionele vrae om by te dra tot die relevansie van die studie. Die vraelyste is na elke Wiskunde onderwyser-student van die SVO gegee. Die navorser het tydens 'n besoek aan Tanzanië self die vraelyste toegedien. Terwyl sommige Finse studente die vraelys aanlyn voltooi het, het ander 'n papier-kopie voltooi, wat per pos aan die navorser terugbesorg is. Beskrywende statistiese tegnieke, geldigheid en betroubaarheid van die instrument, afleibare statistiek (ANOVA), en kruistabulasies is gebruik, en waar van toepassing, is effekgroottes bereken. Bevindings het aangetoon dat die onderwyser-studente 'n positiewe houding teenoor rekenaars toon het en bereid is om IKTs in hulle eie studies, asook in hul onderrig te gebruik. Die vergelyking van rekenaarhoudings het getoon dat die Suid-Afrikaanse en Tanzaniese onderwyser-studente 'n meer positiewe houding teenoor IKTs toon het as die Finse studente. Die onderwyser-studente in die twee Afrikaanse lande was meer bereidwillig om IKTs te gebruik as die Finse studente, ten spyte van hulle hoë vlakke van blootstelling en toegang tot IKT. Verskeie faktore is uitgewys as belangrike faktore in die ontstaan vir 'n effektiewe Wiskunde-onderrigomgewing. Wiskunde onderrig, ondersteun deur toepaslike pedagogiese inhoudskennis, kan omskep word in effektiewe Wiskunde onderrig met behulp van 'n positiewe rekenaarhouding en 'n bereidwilligheid om IKT te gebruik. Hierdie aspekte word ondersteun deur die tegnologiese pedagogiese inhoudskennis (TPCK) raamwerk.

Soekwoorde

Wiskunde-onderrig

Rekenaarhouding

Loyd and Gressard Computer Attitude Survey (CAS)

Houding jeens IKT

Houding jeens Wiskunde

Vergelykende studie

Onderwyser-studente

Kwantitatiewe analiese

Inligting- en kommunikasietegnologie

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List of Acronyms

ACE	Advanced Certificate in Education
ANOVA	Analysis of Variance
CAM	Computer Attitude Measure
CAS	Computer Attitude Survey
CD	Compact Disc
DTUS	Development of the technology use scale
DVD	Digital Video Disc
HSRC	Human Sciences Research Council
HSD	Honestly Significant Difference test
ICT	Information Communication Technology
ICT-TPCK	Information Communication Technology - Technological Pedagogical Content Knowledge
IEA	International Association for Educational Achievement
IETC	International Education Technology Conference
IT	Information Technology
MP3	Moving Picture Experts Group MPEG-1 Audio Layer-3
NADEOSA	National Association of Distance Education and Open Learning in South Africa
NEPAD	New Partnership for Africa's Development
NRF	National Research Foundation
NWU	North-West University
ODL	Open Distance Learning
PCK	Pedagogical Content Knowledge
PISA	Program for International Student Assessment
SCTE	School of Continuing Teacher Education
SITES	Second Information and Technology in Education Study
SMS	Short Message System
SPSS	Statistical Package for Social Sciences
TCK	Technological Content Knowledge
TIMSS	Trends in International Mathematics and Science Study
TPCK	Technological Pedagogical Content Knowledge
TPK	Technological Pedagogical Knowledge
UK	United Kingdom
VCR	Videocassette Recorder

Chapter One

Introduction and Statement of the Problem

1.1 Introduction

Country wide, schools, colleges and universities face a huge problem of low achievements in Mathematics. In the 2003 Trends in International Mathematics and Science Study (TIMSS), the third in a cycle of international Mathematics and Science assessments of Grade 8 learners, South Africa was ranked last of 46 participating nations. Some of the participating countries were also developing countries (Mullis *et al.*, 2003: 342). To compound this problem, many Mathematics teachers are not adequately qualified to teach in this subject area. According to the TIMSS Report, only 45% of the Grade 8 learners were taught Mathematics by a fully certified teacher (Mullis *et al.*, 2003: 342). The School of Continuing Teacher Education (SCTE) at the North-West University who offers, amongst other courses, a distance education course in Mathematics education, experiences similar problems. Many teacher-students who enrol for studies at the SCTE come from poor and rural communities in which they most likely did not receive a good Mathematics education themselves. Many of these teacher-students do not pass their Mathematics modules (School for Continuing Teacher Education, 2008: 9). This leads to the frustration of teacher-students when they have to repeat Mathematics courses, pay additional class fees, and drop out of their studies. Considering the 2005 intake for the Advanced Certificate in Education (ACE), 113 of the 1775 students did not complete their module, although the throughput rate of 1775 teacher-students was 92.5% after maximum duration of study (including cancellations and terminations). The intake for 2006 for the same course had a throughput rate of 97.3% (Kok, 2009: 15).

Some scholars argue for the use of digital media in teaching as they believe that Information and Communication Technologies (ICTs) add value to the learning environment. ICTs seem to create authentic, vibrant and interactive environments that stimulate many students. The concern however is that digital tools could add a dimension of complexity that students in developing countries have to deal with in addition to solving mathematical problems (Lantz-Andersson *et al.*, 2009: 342). ICT provides students with fascinating, interesting, exciting and thought-provoking real-life challenges which can bridge the gap between Mathematics learned at school and real-life Mathematics (Yushau *et al.*, 2005: 20). ICT also allows students to explore and appreciate the beauty and value of Mathematics and can make a difference to the traditional teaching methods that appear to be so prevalent. It allows the teacher

to provide situations where a challenging learning environment is created in which learners' inventive potential can be fostered (Yushau *et al.*, 2005: 20). These arguments indicate that students should find it easier to understand tasks presented through the medium of ICT than in a traditional, verbal context (Lantz-Andersson *et al.*, 2009: 327).

ICT is viewed not only as a technical skill, or as a means of improving learning effectiveness, it is also a way of shifting the goals and processes of education (Law *et al.*, 2008: 14).

Young people who have regularly been exposed to, and interacted with ICT, develop a different approach to learning and the organization of knowledge (Law *et al.*, 2008: 14). The availability and influence of ICT offers new opportunities for students to analyse their mathematical thinking and also to communicate. ICT can encourage generalisation and justification by enabling fast and accurate computation, collection and analysis of data (Goos *et al.*, 2003: 74). It also has the potential to provide students with rich learning environments, allowing them to adopt varied perspectives on complex issues and cater for individual differences (Sang *et al.*, 2010: 103). When teachers are trained and are able to direct students to use ICT in higher-order concepts, ICT is linked to a significant gain in Mathematics achievement (Usun, 2007: 1).

According to the Second Information Technology in Education Study (SITES 2006), the reasons for, and the ways in which teachers use ICT in the classroom, are underpinned by their overall pedagogical competence and vision (Law *et al.*, 2008: 18). Their pedagogical practices are determined not only by their academic qualifications and ICT-competence levels, but also by school and system-level factors (Law *et al.*, 2008: 19). There are vast differences in the access to ICT and resources in South Africa due to the supply of electricity and availability of a land line at schools (Howie & Blignaut, 2009: 347). Many of the teacher-students at the SCTE live in deep rural areas where access to computers is either nonexistent or extremely limited. This directly influences the computer literacy of these students. Although ICT is readily available at many schools in urban areas, extremely primitive technology or a total lack thereof exists in rural areas (Howie & Blignaut, 2009: 350).

Although research has been done on the effectiveness of computer-based instruction in the classroom, the effectiveness in distance education courses requires further investigation. Digital technology is undoubtedly making its way into classrooms, but not that much is known about the effect on school Mathematics and the kind of learning activities that are presented (Lantz-Andersson *et al.*, 2009: 327). Computer-supported learning has revealed positive results on learner performance, especially in problem solving since learners can work in collaboration with each other in solving problem-based tasks (Wang, 2008: 412). Kinsella

(2009: 956) has explored the use of mobile technology to interact with large groups of students and states that to his knowledge, no other methods of communication are able to provide ease of use, speed of transmission and student-feedback in a manner as cost-effectively as through the mobile phone.

ICT can benefit Mathematics students by motivating them in their learning of Mathematics and their enjoyment of the subject. The use of appropriate software packages enhance, sustain and mediate the learning of mathematical concepts (Berger & Cretchley, 2005). Various information and communication technologies could be used for this purpose, inter alia online instruction, mobile technologies, MP3 players (Moving Picture Experts Group MPEG-1 Audio Layer-3), iPods, etc. According to the SITES study of 2006, when compared to other countries, South African schools had the fewest technology applications and facilities available except for the following: mobile devices, smart boards, email facilities for teachers and email facilities for students (Howie & Blignaut, 2009: 353). Students' attitudes, whether they are positive or negative, influence how the students respond to their materials presented in an instructional learning environment (Teo, 2008: 1635). Attitudes to computers play an important role in determining the extent to which students accept the computer as learning tool and also determines the extent to which computers can be used in the future for learning and studying (Teo, 2008: 1634).

The purpose of this study is therefore to determine the teacher-students' attitude towards computers in order to plan for effective, efficient and appropriate methods of Mathematics education to assist teacher-students to raise their motivation for learning Mathematics and improving the throughput rate. The results of the SITES 2006 study indicate that less than 20% of Mathematics teachers use ICT in teaching and learning activities, where administration and learner feedback features the most. Only 16% of South African Mathematics teachers have ever used ICT with the target class (Howie & Blignaut, 2009: 358).

Essential conditions for integrating ICT in the classroom are not in place in most South African schools and even where the hardware and software is in place, significant attention is required regarding the location of ICT, provision of staffing and the acquisition of skills and pedagogy (Howie & Blignaut, 2009: 360).

1.2 Background to the Study

We are living in an age of rapidly advancing technology. ICT provides endless possibilities to provide new approaches to teaching and learning. Learning with technology can promote understanding by encouraging higher-order thinking, self-regulated learning and co-operative learning (Chen, 2008: 68). The use of an adequate technology can assist teachers in becoming more effective in preparing, presenting and transferring knowledge, which aids in the nourishing, inspiring and improving of student development (Hu *et al.*, 2003: 228). The evolution of technology and also Internet application has created new ways of communication which impacts on all regions and sectors including educators and learners and also higher education institutions (Ismail & Idrus, 2009: 55). Researchers and practitioners continue to investigate alternative strategies and approaches that motivate and engage students in Mathematics and allow conceptual learning to take place. One such alternative is technology-based courses which often make use of real-world problems, and are intended to increase student motivation and help students to learn more conceptually (Offer & Bos, 2009: 1136).

Many studies have investigated the relationship between gender and attitude towards ICT. Many of these report that there are no significant differences in computer skills and computer attitude, yet some still indicate that female students are less sensitive to computing than male students (Bekirogullari *et al.*, 2007: 4). However, there is a positive relationship between effective teaching and learning and the use of ICT. Teacher attitudes towards ICT and technology in general influence their students' attitudes towards ICT both positively and negatively (Usun, 2007: 1).

Teachers' positive attitude to computers is greatly influenced by their perceptions of the usefulness of computers and will evidently influence the teaching and learning process. The level at which computers can be used successfully in education is directly dependent on the teachers' attitudes to ICT (Sa'ari *et al.*, 2005: 70). Attitude is however not the only important factor. Being competent in using computers is also an essential feature. Both these aspects play an imperative role in establishing the development of teachers in integrating ICT into the teaching and learning process. This means that for teachers to come to their full potential in ICT, it is necessary for them not to only develop a positive attitude to computers but they also need to attain a high level of competency relating to computers in order to improve the implementation of technology in the education system. Being able to use a computer assists in accumulating new skills and knowledge, but learning also takes place through every day trial and error type activities as are presented by the computer (Sa'ari *et al.*, 2005: 70).

A study that examined Algebra students' achievement in online and traditional learning contexts indicated that the online course was able to provide successful, alternative learning opportunities for students in which they were able to maintain similar academic standards and levels of achievement. This study provides evidence that virtual students can be exposed to skilled teaching through quality material and can achieve academically (Hughes *et al.*, 2007). The delivery of education has benefited from the advancement in ICTs and has contributed to the shrinking of the distance between course facilitators and students. This has led to dramatic increases in Open Distance Learning (ODL) and the use of e-learning where learning is no longer bound by the limitations of the traditional classroom. ICT has been described as a powerful tool in the context of teaching and learning that can create variation to the traditional method of teaching. It is able to strengthen and systematize the process of learning. Computers in particular assist in creating a rich and challenging learning atmosphere in which creativity can flourish (Yushau *et al.*, 2005: 12).

For Mathematics specifically, there are a number of tools that can be used to assist students in problem-solving and exploring mathematical concepts. Technology can enhance students' problem solving, sustain the exploration of mathematical concepts and can promote meta-cognitive functions such as planning and checking. ICTs can simulate real life situations to which Mathematics is applied to the classroom in the form of digital cameras, video cameras, data loggers and software (Pierce *et al.*, 2007: 286). Much research has been done on the effect of the computer on pedagogy especially in developing countries which are educationally and economically disadvantaged, and access to this technology has only recently become available. Hardman (2005b: 100) reports that the introduction of a new "tool" such as the computer into the environment creates conflict in the given context and therefore is able to alter the practices readily used. ICTs can be viewed as an enormously influential tool for discovering Mathematics. One of the advantages of such exploration is that it provides powerful visual images and intuitions that can aid students with the understanding of Mathematics. The computer also provides the means for students to formulate and test many conjectures (de Villiers, 2003: 176).

A study in 2006 which involved ODL students enrolled for the diploma in primary education at the University of Botswana, aimed to determine whether the students had access to MP3 players and other technology which could be used in distance education (Kabonoki, 2008: 113). It was revealed that students preferred to use familiar technologies and showed apprehension for using computers in learning. Similar studies were performed in 1999 and in 2000 and when compared to the 2006 study there was an indication that the students were

slowly drifting towards digital technology, yet only 17,3% of the population had access to computers and 3,7% were connected to the Internet. When asked if they would rather use computers if the same audio instructions, which were previously available on cassettes were available on computer, students indicate that they would not. Other factors could have played a role, for example that the sample was dominated by female learners (90,2%), who have been shown to have higher anxiety levels concerning computer use. When asked if the same audio instructions were on video, would they use the video, the responses were overwhelmingly positive. This could be due to the fact that video technology was more accessible at home than computers. The level of access of the population to television is 78,8%. In general, the study revealed that students are not keeping up to date in the emerging ICTs such as MP3 mobile audio devices, but they have access to CD and DVD players and cell phones. The high access to mobile phones is positive since they could bridge the gap in creating easier access to the Internet (Kabonoki, 2008: 113).

The limited contact time between lecturer and student in the context of distance learning creates an ideal opportunity to introduce technology as a means of providing additional support to students. It is however important to investigate students' attitude to and reaction towards technology and specifically computers before designing any programme involving the use of ICTs such as computers, mobile phones or MP3 players. Access to the Internet is no longer limited to the use of a computer screen and keyboard. With the rapid advancement of mobile phone technology, mobile phones are able to function as mini-computers which allow not only Internet access, but even the use of software packages like word processors etc. (Durndell & Haag, 2002: 523).

Attitude determines peoples' behaviour and is consequently essential in issues involving education. Positive attitudes can be interpreted as an indication that a new program may be successful. Various studies have shown that students display different reactions to using computers, both positive and negative. This would therefore influence the way in which they learn, either enhancing learning or interfering with learning (Yushau *et al.*, 2005: 176). Computer attitude has also been defined as a person's general evaluation or feeling of favour or antipathy towards computer technologies and specific computer-related activities. The evaluation of computer attitude usually involves statements that examine the user's interaction with computer hardware and software, other people relating to computers and activities that involve using a computer (Smith in Usun, 2007: 927). The worldwide use of and the dynamic nature of ICT has led to the need to understand why people accept or reject computers, hence the reason why researchers have tried to investigate attitudes to computers (Usun, 2007: 798).

As personal computer use as well as use in schools and business increased in the late 1980's, research on computer attitudes became popular in that time (Popovich *et al.*, 2008: 987). Loyd and Gressard's computer attitude survey (CAS) is one of the tests that is often applied to undergraduate students and professional educators (Yushau *et al.*, 2005: 180). CAS can be divided into a number of variables, namely computer anxiety which assesses the fear of computers, the liking of computers which assesses the enjoyment of dealing with computers, the perceived usefulness and ease of use of the computer, self-confidence and perceived consequence for society and the proliferation of computers on future jobs (Usun, 2007: 798; Yushau *et al.*, 2005: 180).

Yushau (2005: 181) used the Loyd and Gressard CAS to investigate the effect of blended e-learning on students' computer and Mathematics attitudes. The students learned pre-calculus in the online and offline approach for one semester, where data were collected relating to the students' attitudes towards Mathematics and the computer at the start and the end of the programme. The data were collected and analysed statistically. Results showed significant correlations between the blended e-learning programme and all items except for computer confidence and anxiety.

In a study at a Midwestern university in the United States of America in which the attitudes of undergraduate students towards computer usage were compared from 1986 to 2005, researchers found that computer attitudes have changed over the twenty years as the use of computers and computer-related mechanisms increased dramatically. The amount of time spent using a computer is positively related to computer attitude and as time progressed, it is more commonplace for students to enrol for computer courses. It was found that the relationship between computer attitudes and computer anxiety remained significantly negative, which means that people with a more positive attitude towards computers are normally less anxious about a computer. The relationship between attitude and anxiety was nearly twice as strong in 2005 as it was 20 years earlier. The gender differences that were found in 1986 were not indicated in 2005. Males and females no longer showed a significant difference in their attitude to computers (Popovich *et al.*, 2008: 991).

Studies on pre-service education students to determine the effect of gender and teachers planning to teach at different grade levels have revealed that gender differences are diminishing, however there is a dramatic difference in the attitudes to computers of teachers teaching (or preparing to teach) different grade levels (Shapka & Ferrari, 2003: 333).

The researcher is unaware of any South African studies on the attitude of open distance learning teacher-students towards the use of ICTs. From the above exposition the question arises: What is the attitude of Mathematics students enrolled for the ACE in Mathematics course towards ICTs? Also, to what extent will these students be willing to use computers?

1.3 Research Aims

This study aims to determine the attitude of Mathematics teacher-students enrolled for the ACE in Mathematics course towards ICTs. The study also aims to determine to what extent these students will be willing to use computers in their own studies as well as in the teaching process in their classrooms. The study further aims to compare these attitudes with those of students in a developing and a developed country i.e. Tanzania and Finland.

1.4 Research Design and Methodology

This study is a quantitative survey design comprising a single mode research questionnaire to three groups of students in three countries. A cross-sectional survey design will be used to collect information from a purposive sample of Mathematics teacher-students (Fraenkel & Wallen, 2003: 397). The population will consist of three groups of Mathematics education students studying at the SCTE, North-West University, South Africa, those studying at the Iringa University College, University of Tumbani, Tanzania and those studying at the University of Joensuu, Finland. The instrument that will be used is based on the Loyd and Gresard Computer Attitude Survey (1984), with a few additional questions to add to the relevance of this study. These questionnaires will be administered to all three groups of students in various ways. Descriptive statistical techniques will be used and reliability and validity will be calculated.

1.5 Contextualisation

It is important to sketch the context of the teacher-students from the three different countries. The student-teachers in South Africa are in-service teachers which mean that they are slightly older than the average student, since they already have a basic education qualification. The majority of the students are from disadvantaged schools and are mainly women (Kok, 2009). The group from South Africa consists of students from both a rural and urban

environment. There are students who live and teach in deep rural areas where there is often not electricity or running water, and also students who live and work in a fully urbanised community like Pretoria and Cape Town. The infrastructure for technological access varies to a large extent due to the diversity of contexts from which the students come. Figure 1.1 illustrates a group of South African students who attended a vacation school at Polokwane.



Figure 1.1 Vacation School Class at Polokwane, South Africa

The teacher-students from Tanzania are also slightly older than the average school-leaving student. This can be ascribed to the fact that financially it is necessary for them to first work after school in order to save money to be able to go to university to study. Their context is similar to that of the South African students, however they mostly live and work in rural areas. The infrastructures in their urbanised cities are less well-equipped than in South Africa, which means that access to technology is also limited and unreliable. Figure 1.2 depicts the computer Science centre at the Iringa University College, University of Tumbani in Tanzania.



Figure 1.2 The Computer Science Centre at the Iringa University College, University of Tumbaini, Tanzania

There is not one gender that dominates the other in higher education in Finland. Very similar numbers of males and females are enrolled as students in Finland. Their average age is much younger than the other two groups discussed since these students are mostly school graduates who go on directly to enrol for their tertiary education. They are therefore pre-graduate students. Finland is considered to be a financially prosperous country in which residents lead a high standard of living. There is no lack of resources of any kind especially the availability of technology and infrastructures to enable engagement with technology. Figure 1.3 represents the first world context of the University of Joensuu, Finland.



Figure 1.3 One of the Buildings at the University of Joensuu, Finland

1.6 Presentation of the Study

A review of the literature will be presented in Chapter 2 in which the main themes of the study will be explored. The research design and methodology follows in Chapter 3 and a presentation of the data and an analysis thereof in Chapter 4. Chapter 5 summarises the most important aspects of the study and conclude with recommendations for further research.

Chapter Two

Literature Review

2.1 Introduction

ICT has in recent years asserted a place in society, and undoubtedly in the educational arena as well. Where the initial emphasis was on learning about ICT, the shift has moved to discovering how ICT can be used as a learning tool in education of all levels (Volman *et al.*, 2005: 36). Although the potential for digital technologies like computers, graphics calculators and the Internet, to enhance students' Mathematics learning is widely recognized, technology still plays an insignificant role in Mathematics classrooms (Bennison & Goos, 2010: 31). To be able to implement ICT effectively in the Mathematics classroom, it is essential to determine students' attitudes towards ICT.

2.1.1 Mathematics Education

In a study that reported on the technology-related professional development experiences and needs of Mathematics teachers in Queensland, it was found that professional development participation is related to greater confidence with technology and more positive beliefs about technology use is beneficial for students' learning of Mathematics (Bennison & Goos, 2010: 52). By using new technologies in the classroom, research has shown that the relationship between computer-supported recreational activities, attitude towards Mathematics, improvement in Mathematics learning and student performance, is promising (Lopez-Morteo & Lopez, 2007; Rosas *et al.*, 2003).

2.1.2 Challenges with Mathematics Education

The Trends International Mathematics and Science Study (TIMSS) is one of the large international studies of Mathematics and Science undertaken by the International Association for Educational Achievement (IEA). It is conducted every four years and assesses achievement in countries around the world. The study collects a variety of information about the educational contexts for learning Mathematics and Science. TIMSS 2003 involved more than fifty participants (Mullis *et al.*, 2003: 3).

The results of TIMSS 2003 revealed that at the Grade 8 level, South Africa was the lowest-performing country with an average of 264, where the highest country, Singapore achieved an average of 605 and the international average was 467 (Mullis *et al.*, 2003: 34). This is no improvement on the TIMSS 1998-1999 results where South African pupils had a mean score of 275, where the international mean was 487 and the highest achiever, Singapore had a mean value of 604. The most proficient South African pupils achieved the level of the average pupils from Singapore (Howie, 1999: 9).

The poor performance in TIMSS and the ever-decreasing matriculation exemption rate in the Senior Certificate Examination is great cause for concern in South Africa. Much research has been done on what makes an effective school, and various characteristics are identified like the composition of the student body, social class and the creation of a learning environment (Papanastasiou, 2007: 62). Researchers argue that schools that achieve highly are characterized by well-organised teaching that motivates students, links to their prior knowledge and keeps learners actively involved in the learning process. Some reasons suggested for poor performance include that students are not able to attain the minimum objectives of the curriculum, all of which might be influenced by unsuitable Mathematics textbooks, insufficient time allocated for teaching and learning and teaching that is poor and does not stimulate the learners (Papanastasiou, 2007: 62). Since the SCTE provides in-service training to Mathematics teachers, who come from a tradition of teaching that does not incorporate ICT in the teaching and learning of Mathematics, it is important to establish how these teacher-students feel about ICT for Mathematics education.

2.1.3 Link between ICT and Mathematics Education

Computer-based instructional material is constantly being developed to contribute to the process of learning Mathematics. The main objective of many of these designs has been to enhance Mathematical skills, foster automaticity of certain Mathematical skills, and develop Mathematical thought among users (Lopez-Morteo & Lopez, 2007: 620).

In a time when Mathematics education appears to be in a crisis, it is important to keep the interest of those who are already motivated to study Mathematics, and develop strategies that will make the study more attractive to those who are not interested. For many students, the integration of computers into the learning of Mathematics is empowering and stimulating, caution should be exercised where students experience barriers to the use of computers in education (Cretchley & Harman, 2001: 21). Although the incorporation of computers is able to provide new opportunities for the teaching and learning of Mathematics and Science, the

development of effective teaching strategies that includes the use of ICT remains challenging for many educators. It is therefore essential that teachers understand the different ways in which technology can facilitate student learning (Hartley *et al.*, 2008: 597).

2.2 Attitude

Attitude can be defined as a learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object. There are three basic features: the notion that attitude is learned, that it predisposes action, and that such actions are consistently favorable or unfavorable toward the object (Fishbein & Ajzen, 1975: 7). The effects of attitude to Mathematics and the effect this has on Mathematics achievement has been studied widely. There is also much information available on the role of attitude to computers, but there is a need to investigate the role of attitudes in the use of computers to learn Mathematics (Cretchley & Harman, 2001: 17).

Whether attitudes toward computers are caused by anxiety or not, they influence an individual's frame of reference and are often formed before an individual even takes up computer training (Conrad & Munro, 2008: 54). A variety of studies have been done over the years regarding computer attitude with varying results, many of which will be discussed in this chapter. Pamuk *et al.* (2009) indicated from their study of Turkish pre-service Mathematics and Science teachers that teachers who took more technology related courses and who owned a computer showed higher levels of computer self-efficacy which in turn relates positively to their computer attitudes. Their results suggest that in order to increase these positive attitudes, teacher education programmes should carefully evaluate the content and design of technology-related courses and improve the quality and accessibility of computer resources (Pamuk & Peker, 2009: 460). According to a study by Meelissen *et al.* (2008: 978), students that come from a more privileged socioeconomic background are more likely to have a positive computer attitude than those from a less privileged background. A possible reason offered for this occurrence is that privileged families are more regularly exposed to computers and are more likely to experience success with computers.

Since positive attitudes towards ICT often predicts future computer use, policy-makers should take heed of teachers' positive attitudes towards ICT to better prepare them for integrating ICT in their teaching practice (Albirini, 2006: 386). Barriers that have been identified in the implementation of technology in education are teachers' low level of access to computers at school, and limited class time (Albirini, 2006: 386).

2.2.1 Computer Attitude Survey (CAS)

Different attitude scales lead to different results regarding the influence of gender on computer attitude or not (Bovee *et al.*, 2007: 1773). For this reason it is wise to use an instrument that was developed and used in various other studies (Francis *et al.*, 2000; Salzer & Burks, 2003). Measuring of computer attitude has long been an issue for many researchers and in 1984 Brenda Loyd and Clarice Gressard developed an instrument known as the Computer Attitude Scale (CAS) (Loyd & Gressard, 1984). The instrument was designed to evaluate student attitudes and the effect they may have on the success of computer-related programmes that are introduced into school curricula. Since research revealed that anxiety towards a subject area like Mathematics may influence the learning process, Loyd and Gressard decided to develop this instrument to determine to what extent the students' attitude towards computers and towards learning about computers may be an important factor in the success or failure of new computer programs (Loyd & Gressard, 1984: 501).

2.2.2 Attitude and Anxiety

More and more teachers are using computers in education, yet not all of them feel comfortable using them. Sometimes resistance is shown with regard to introducing computers into the educational task, which results in delays in computer adoption in education. Some of these negative attitudes can be attributed to their anxiety towards computers (Yaghi & Abu-Saba, 1998: 321).

A commonly quoted definition for computer anxiety is a negative emotional state and/or negative cognition experienced by a person when he/she is using a computer or imagining future computer use (Bozionelos, 2001: 956). Various studies have investigated different components of computer anxiety such as: computer anger, computer use, computer self-efficacy and computer experience, and the effect that these have on attitude.

One study indicates that a person's attitude towards computers impacts on the effect of that person's level of computer anxiety on job satisfaction and stress (Parayitam *et al.*, 2010: 351). They call on academic institutions to focus on computer training so that computer anxiety can be used as a positive force, and positively influence performance. In a study that analyzed the relationship between computer use, which includes frequency and duration of use, computer experience and self-efficacy beliefs of the users, the results indicate that of the three aspects mentioned, computer self-efficacy has the closest relevant relationship with computer anxiety and anger (Wilfong, 2006: 1008). He suggests that self-efficacy beliefs

should be increased so that users may experience lower levels of anxiety and anger. Shih (2006: 1012) confirms these findings and also identified self-efficacy as having a positive effect on perceived consequences. Also, this study reveals that computer competence directly and indirectly affects individual satisfaction with computer use.

Another study in the late 90s explored the extent to which computer anxiety test scores can predict users' ability to complete basic computer operations accurately and swiftly, keeping in consideration the user's experience. Once again computer anxiety, computer avoidance, computer experience, state anxiety and the accuracy with which they could perform a basic computer task were measured. The data confirmed previous findings that computer anxiety is associated with elevated levels of computer avoidance and state anxiety. It also revealed that computer anxiety is associated with slower completion of simple computer tasks. This performance deficit is independent of the prior level of computer experience and the level of state anxiety of the user (Mahar *et al.*, 1997: 683).

When investigating the link between Internet anxiety, computer anxiety, Internet self-efficacy and computer self-efficacy of teacher students', a study showed that Internet anxiety is to a large extent influenced by computer anxiety (Ekizoglu & Ozcinar, 2010: 5889). Also, higher levels of computer self-efficacy are associated with more positive attitudes towards technology and relatively low levels of computer anxiety (Conrad & Munro, 2008: 65). Students with low levels of computer confidence and self-efficacy show strong feelings of anxiety and disadvantage at the prospect of using software for learning (Cretchley, 2007: 23).

2.2.3 Attitude and Gender

Over the past number of years, studies ascertained the influence of gender on computer attitude. Research on gender issues in ICT has shown that in most countries, girls and women are often behind in ICT use, ICT knowledge and skills. In many Western countries, the rate of females' involvement in ICT professional careers is not only low but on the decline (Meelissen & Drent, 2008: 970). The logical trend then for policymakers is to place high expectations on schools and teachers to make ICT more attractive for girls, for example teachers are expected to select and use educational software that is attractive to both boys and girls. When looking closer at literature, a lot of research shows that gender differences in computer attitudes are linked to factors that are non-school related like computer experience, accessibility of computers at home, computer skills, the masculine image of computers and parents' computer attitudes and use (Brosnan, 1998: 207). Meelissen and Drent (2008: 983) consequently did work on the effect of school-related as well as non-school related factors

like contextual school characteristics, cultural school characteristics and structural and cultural teacher characteristics on computer attitude. They were able to conclude that two school related factors turned out to have a positive effect on the computer attitude of girls: a teacher-centred pedagogical approach and the computer experience of female teachers.

Research which examines issues relating to the use of ICT, gender and ethnic differences found small differences regarding gender in primary schools, but found more significant ethnic differences (Volman *et al.*, 2005: 50). Learners from an ethnic-minority background use the computer more often to practice what they have learned at school, but they use e-mail and surf the Internet less than learners from the majority population. They also perceive themselves as less skilled in word processing and Internet use than the pupils from the majority population and are more positive about computers (Volman *et al.*, 2005: 51). In the secondary school, as much literature has already pointed out, girls use the computer less at home than boys and do not like programming and games. Ethnic differences in secondary school is much like that of the primary school (Volman *et al.*, 2005: 51).

Although different studies reveal varying results, it appears that most studies are consistent in concluding that in general, females have less positive attitudes to computers than males, however females' attitudes to computers are seldom negative (Bovee *et al.*, 2007: 1763; Meelissen & Drent, 2008: 978; Volman *et al.*, 2005: 36). Males also tend to judge their self-efficacy in computer use as more positive than females (Meelissen & Drent, 2008: 979). Male teachers tend to have more knowledge on ICT and their use of ICT in education and attitude towards the Internet is more positive than that of female teachers (Tezci, 2009: 1291). There is a follow-on effect of a positive attitude which could in future influence investigations. The more positive a students' attitude to computers, the more likely they are to show interest in and be willing to use computers which results in an even more positive attitude to computers (Meelissen & Drent, 2008: 979). These gender differences are characteristic in both countries where ICT is easily accessible and not, like the South African context (Bovee *et al.*, 2007: 1763).

Where the pedagogical approach of the school has no effect on boys' computer attitude, girls in schools that follow mainly a student-oriented approach in which students are encouraged to do self-learning, appear to have less positive attitude to computers when compared to the mainly teacher-centred approach, where the teacher controls the learning process completely (Meelissen & Drent, 2008: 980). Their study shows that both boys and girls are positive about computers in general and about using computers at school. They stress the importance of schools and teachers being aware of the differences in attitude, using computers

out of school and self-efficacy in computers, and that they should try to prevent that these differences lead to more barriers for girls when ICT is used for learning activities, especially in a more student-oriented environment (Meelissen & Drent, 2008: 984).

2.2.4 Computer Experience and Attitude

A positive correlation exists between computer experience and computer attitude which implies that students with more computer experience are more likely to have a positive attitude towards computers (Bovee *et al.*, 2007: 1771; Tezci, 2009: 1291). The use of ICT in the classroom is also influenced by the teachers' level of experience; the higher the level of knowledge on ICT the higher its level of use in education (Bovee *et al.*, 2007: 1772; Tezci, 2009: 1291). Earlier involvement with computers can lead to a more positive attitude (Bovee *et al.*, 2007: 1774). In a study on computer attitudes of primary and secondary students in South Africa, six of the eight schools can be classified as upper middle class schools and two of them are classified as township schools, results showed that the students from the township schools did not show a negative attitude to computers despite their lack of experience with computers, they surprisingly showed high interest in computer-related careers (Bovee *et al.*, 2007: 1774). This emphasises the importance of including the opportunity of education with ICT especially for students from lower classes (Bovee *et al.*, 2007: 1774). ICT and the use of computers in schools provides underprivileged students with access to a world outside of the narrow confines of their own world (Hardman, 2005a: 264).

The less years of experience a teacher has, the higher their knowledge and use of ICT, and the more positive attitude they have than those teachers with many years of experience (Tezci, 2009: 1291). And as could be expected, as ICT experience increases, so their attitudes also improve, which has far-reaching effects on teacher training. The way in which teacher training is designed is an essential factor in the effective use of ICT in the teaching-learning process (Tezci, 2009: 1292).

2.2.5 Teacher Attitude Influences Student Attitude

In a study that explored the effect of teacher factors on students' ICT beliefs, it was found that the way in which students perceive teacher expectations, teacher instructional practices and even parental support are related to student motivational beliefs about ICT. Perceived expectations of the teacher relate positively with what students believe about their own computer competence (Vekiri, 2010a: 22).

Teachers appear to be disinterested in paying attention to ICT and diversity in the form of gender and ethnic differences between pupils. It appears that they are too busy simply introducing the idea of ICT, and using ICT in lessons that they are not too concerned about such differences and the impact thereof on teaching and learning (Volman *et al.*, 2005: 52). Volman *et al.* (2005: 53) indicate the importance in both primary and secondary education that girls encounter positive role models in ICT use, like female teachers who have extensive expertise in ICT and a positive attitude towards the use of ICT so that the imbalance in attitudes relating to gender can start to be corrected. Teachers who are gender sensitive and culturally sensitive are most likely to achieve success when developing and selecting teaching material (Volman *et al.*, 2005: 53).

The use of ICT in the classroom is related to teachers' attitudes and levels of skill and knowledge necessary to carry out these educational innovations. One of the main problems is that training teachers is expensive and is often neglected (Pelgrum, 2001: 165). Teachers' behavior is affected by their attitudes which have a huge effect on openness to new activities and experiences and also on reflecting on and implementing change (Tezci, 2009: 1286).

The successful implementation of educational technologies depends to a large extent on the attitudes of the teachers, who ultimately decide how it will be used in the classroom (Albirini, 2006: 375). Positive attitudes can encourage less technologically competent teachers to learn skills that they need for implementing technology-based activities in the classroom (Albirini, 2006: 376). Knezek and Christensen (as quoted by (Albirini, 2006: 376)) analysed several studies in the 1990's that relate to ICT in education, propose that teachers advance in the process of technology integration through a set of well defined stages, which often requires changes in attitude rather than changes in skill.

Many studies have revealed a wide range of factors that influence attitudes towards ICT. Albirini (2006: 376) suggests that these variations that have been identified by the different researchers could be ascribed to different contexts, participants or the type of research done.

2.2.6 Factors that Influence Attitude

Schools play an important role in developing students' literacy with regard to ICT. For many learners, especially those from low socio-economic backgrounds, the school is the only context where they can get acquainted with ICT's and have an opportunity to develop their technological expertise (Vekiri, 2010b: 948). Despite the school being the platform for many

learners to make acquaintance with ICT, teachers play an extremely important role in learners' attitude towards ICT, both positive and negative.

A study that investigated the effect of variables like teacher belief, teacher efficacy and teacher attitude towards ICT concluded that teacher attitude to computer use in education appeared to be the strongest predictor of prospective computer use (Sang *et al.*, 2010: 109). Teachers' own pedagogical beliefs and values and their perceptions of innovative use of ICT play an important role in shaping technology-mediated learning opportunities especially in Mathematics and numeracy (Way & Webb, 2006: 22). When new technologies are introduced in schools, teachers need a considerable amount of time to develop their skills and confidence in using the technology in their classroom context (Way & Webb, 2006: 24). Teachers' attitudes towards computers are not only influenced by cultural norms, but also by their own computer competence (Albirini, 2006: 377). In a study that investigated the attitudes of high school teachers in a Syrian province towards ICT, it was found that their positive attitudes correlated with their perceptions of computer attributes. Respondents were most positive about the advantage of computers as an educational tool, however, most were not certain about whether or not computers fit into the goals of the curriculum, and believe that the lack of class time impeded on the incorporation of computers (Albirini, 2006: 384).

Teachers are the most important driving force behind change with regard to technology in the classroom than any other role player (Albirini, 2006: 374). Teachers who use ICT in an innovative way can be characterized by a specific combination of knowledge, skills, attitudes or competencies that are an advantage for the innovative use of ICT (Drent & Meelissen, 2008: 197).

Learners' attitude towards ICT could also be influenced by the subject for which ICT is being used. Attitudes to Mathematics can directly influence attitude to computers (Vale & Leder, 2004: 306). Children's relationship with ICT can be influenced not only by their teachers, but by their parents who are the ones to provide technological resources, provide learning opportunities and communicate their own values and objectives regarding their children's ICT use (Vekiri, 2010b: 942). The level of parents' concern about the effect of Internet use on their children is influenced by the parents' technological capacity. Parents with more advanced knowledge of technology are less open to the possibility that physical contact with a teacher and classmates can be replaced by digital ones on the screen, like videoconferencing (Anastasiades *et al.*, 2008: 1536).

A study that explores ICT integration from a school improvement approach identifies a number of determinants that are significant in the use of ICTs: there needs to be a shared vision about ICT between principals and teachers; the number of teachers that attend in-service training is important; the availability of school internal ICT support and the pupil/PC ratio at school. Successful ICT integration is closely related to issues at school level like the development of an ICT plan, ICT support and ICT training (Tondeur *et al.*, 2008: 220).

2.3 Value of ICT

The increasing importance of ICT in South African society cannot be ignored. The labour market is becoming more difficult to access without relevant ICT knowledge and skills and the gap between a small group of people who have access to ICT skills and a large group of people who do not, seems to be widening (Bovee *et al.*, 2007: 1763). Technology does not have an educational value in itself, however, it becomes important when teachers make use of it in the teaching-learning process (Tezci, 2009: 1285).

2.3.1 Effect of ICT on Pedagogy

Technology has influenced teaching and learning environments in the areas of communication, learning and teaching. ICT not only offers many opportunities to learners, but also has changed the teaching methods and beliefs of teachers (Erdogan & Sahin, 2010: 2707). The computer can be seen as a tool that can potentially re-engage children in learning Mathematics which influences the development of creative students who are interested in Mathematics (Hardman, 2005a: 264). The computer can be used to alter student's motivation with regard to Mathematics which suggests that by introducing computer technology into disadvantaged schools, there will be an impact on pedagogy (Hardman, 2005a: 264).

ICT appears to be promising in assisting educators to provide equal educational opportunities because it is able to assist in gradually transforming current educational practices. It is also able to provide continuing feedback regarding pedagogical or educational effects and processes (Mooij, 2004: 27). ICT provides opportunities to access a wealth of information using various resources and provides the ability to view information from multiple perspectives, thus nurturing the genuineness of learning environments. ICT can also make complex processes easier to understand which contributes to authentic learning experiences (Smeets, 2005: 344). Teachers' views on how ICT can contribute to the learning environment and perspectives on pedagogy play an essential role in their use of ICT in the classroom (Nieder-

hauser & Stoddart, 2001: 27). Further to this, Nederhauser *et al.* (2001: 27) found a consistent relationship between teachers' perspectives about the instructional use of computers and the type of software that they used with their students. Those who used open-ended software had a strong learner-centred orientation and a weak computer-directed orientation, while teachers who used skill-based software had a stronger computer-directed and lower learner-centred orientation.

Teachers who are more confident about their skills in using ICT, and who value ICT as a way in which to support learners' autonomous learning are more likely to use open-ended ICT applications in their classrooms. Skill-based ICT is also used more frequently by teachers who feel that ICT contributes to independent learning and curriculum differentiation (Smeets, 2005: 352; Tondeur *et al.*, 2007: 972). Computers are used to complement rather than change existing pedagogical practices (Smeets, 2005: 353).

One of the added benefits of ICT in education is related to the flexibility in the means of delivery which makes it possible to learn independent of time and place and at each person's preferred tempo (van Merriënboer & Brand-Gruwel, 2005: 413). This makes ICT ideal in the distance education context. ICT makes it possible to confront students with more information than was possible before and to present large amounts of information (both relevant and irrelevant) (van Merriënboer & Brand-Gruwel, 2005: 413). It also enables new forms of communication and collaboration between learners and enables the use of simulation in education (van Merriënboer & Brand-Gruwel, 2005: 414).

According to the Second Information and Technology in Education Study (SITES 2006), teachers reported that using ICT in their teaching had more access to new content and led to them making use of more varied learning activities and resources. More than 50% of the teachers claim that their ICT-use had increased the quality of their instruction and coaching, increased their ability to adapt their teaching to individual students, increased their self-confidence and increased teamwork among their students (Voogt, 2008: 250).

2.3.2 Competence in ICT

It is essential for teachers and teacher-students to benefit from computer and Internet in both their learning and teaching process. Computers and the Internet provide us with the opportunity to access masses of information, share information and they provide endless opportunities in distance learning (Ekizoglu & Ozcinar, 2010: 5883).

Teachers' use of ICT for their own professional development is determined by concerns emerging from their specific professional environment which could be the main drive for teachers' self-directed professional development (Mushayikwa & Lubben, 2009: 377). Teachers find computer technology useful in improving their instructional performance and assists in motivating their plan to use computer technology in the future. The perceived usefulness directly influences the teachers' intention to use computer technology (Ma *et al.*, 2005: 393).

A project in the UK which explored the views of trainee teachers on factors influencing the effective use of ICT in their subject teaching resulted in them claiming that doing something with ICT that had a positive impact on the quality of teaching and learning, had a powerful impact on their progress in ICT and their determination to explore the potential of technology in the future (Haydn & Barton, 2007: 1031).

ICT in education is often seen as a means to revolutionise educational systems by acting as a tool to bring about educational reform (Pelgrum, 2001: 163). By integrating ICT into the curriculum, learners can benefit in various ways. Exposure to ICT will provide learners with valuable practical experience and will give them the opportunity to learn and develop skills that will be useful in a work environment that is becoming increasingly technology-saturated. Also by integrating technology across the curriculum, learners have the opportunity to create knowledge in their own right. The kinds of skills that can be developed like personal information management, self-regulated learning and working, research capabilities combined with good communication skills are highly prized in the job market, both locally and abroad. These skills can be learned quicker and more effectively through the use of ICT (Howie & Paterson, 2005: 3).

2.3.3 ICT in Developed and Developing Countries

Both developed and developing countries have established national ICT policies and investments to increase the quality in education, to provide work, power and to provide education to those who are proficient in ICT (Tondeur *et al.*, 2007: 963). There is a need to consider cultural factors in studies of computer attitude, especially in developing countries (Albirini, 2006: 385).

Many governments in developing countries are initiating programs to introduce computers into education (Albirini, 2006: 374). Developing countries have the responsibility to provide schools with computers and also to foster a culture of acceptance among those who are to

use the tools (Albirini, 2006: 386). Syria is one such country that is pursuing the use of technology in education. Although the Syrian government recently adopted a plan to introduce ICT into education by equipping laboratories in secondary schools for vocational and technical education, and has also connected many schools to the Internet, the plans seem to lack consideration of the teachers' reaction to this new innovation since their attitudes play an essential role in the success or downfall of any such implementation (Albirini, 2006: 374). The importance of teachers' attitudes cannot be overlooked, hence the need for this study. To help prevent developing countries from falling even further behind in the information age, the governments of these countries need to provide their citizens with the opportunities that ICT might offer (Howie & Paterson, 2005: 1). In many developing countries the introduction of computers is considered to be a positive step towards globalization and improving education in general. There is however not much information on how the incorporation of computers will be implemented (Hartley *et al.*, 2008: 598).

2.4 ICT and Mathematics

Mathematics is traditionally seen as a difficult subject and many students prefer not to do Mathematics if given the choice. The quality of teaching and learning at the secondary level in Mathematics and Science determines the number of students that are trained in the field of Science, engineering and technology (Hartley *et al.*, 2008: 596).

Considering the role of technology in Mathematics and Science curricula, teacher education programmes should view technology as an essential aspect of teacher training (Pamuk & Peker, 2009: 454). Teachers are expected to be technologically literate by making use of technology into their practice (Pamuk & Peker, 2009: 454). In teacher education programmes, computer-related courses and practical hours spent doing the courses, provide teachers with the knowledge and skills necessary to incorporate technology into their teaching (Kadijevich, 2006; Pamuk & Peker, 2009: 454). Since the computer can influence children's motivation, it has the potential to re-connect children in learning Mathematics which is essential in developing creative students who are interested in Mathematics (Hardman, 2005a: 264).

In a study that examined the role of computer confidence in a technology-enriched Science and engineering course at an Australian university, it was found that computer confidence is a very different construct to Mathematics confidence. Mathematics confidence is more

closely related to students' performance than computer confidence on different types of tasks, including those that required the use of technology (Cretchley, 2007: 35).

2.5 ICT and Distance Education

Mobile technology, like mobile phones, is very much part of a students' life, regardless of whether they are full-time students or not. Mobile phones are always within reach and can easily be accessed and because they are small and familiar, mobile phones can be quite unobtrusive in the classroom. Another benefit is that users require no training in technology and most are not intimidated by a mobile phone (Ismail & Idrus, 2009: 55). Although this is a relatively new field of study, the use of mobile technology in education is proving to be very useful. Institutions working with distance education are increasingly faced with challenges to respond to this changing technological environment in order to enhance the effectiveness of learning in distance education (Ismail & Idrus, 2009: 55).

2.6 Conceptual Framework for Using ICT in Mathematics Education

Research in the area of teaching with technology has been criticized for a lack of theoretical grounding (Mishra & Koehler, 2006: 1017). Some conceptual frameworks have recently been offered for research in educational technology, and will be discussed in this section.

The knowledge of teaching subject matter is defined by Shulman (1987: 8) as pedagogical content knowledge (PCK). It represents the blending of content and pedagogy into an understanding of how topics, problems or issues are organized, represented and adapted to the interests and abilities of the learners and presented for instruction. Pedagogical content knowledge is the category most likely to differentiate between the understanding of the content specialist and that of the specialist in pedagogy (Shulman, 1987: 8).

Mishra and Koehler (2006: 1017) have expanded on Shulman's work by attempting to capture some essential qualities of teacher knowledge required to integrate technology into teaching. They argue that thoughtful pedagogical use of technology requires the development of a complex form of knowledge that they call Technological Pedagogical Content Knowledge (TPCK). Mishra and Koehler (2006: 1026) discuss the components of content, pedagogy and technology separately, but also discuss their role in pairs: pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowl-

edge (TPK) and all three together, technological pedagogical content knowledge (TPCK). Technology cannot be treated as a knowledge base that is unrelated and separate from knowledge about teaching tasks and contexts; it is about what technology can do for the teacher (Koehler *et al.*, 2007: 743).

According to Shulman (1986: 9), content knowledge refers to the amount and organization of knowledge in the teacher's mind. Teachers need to be able to explain to students why a particular concept is necessary, why it is worth knowing and how it relates to other concepts. Content knowledge is the knowledge, understanding, skill and disposition that are to be learned by school children. Teachers must clearly know and understand the structures of subject matter, the main facts, concepts, theories and procedures as well as have the depth of understanding necessary to teach the particular subject. It is the teacher's responsibility to influence student understanding, which places demands on the teacher's own understanding of the subject matter and also on the teacher's attitude toward what is being taught and learned (Shulman, 1987: 8).

Pedagogical knowledge is knowledge about the processes and methods of teaching and learning and how it encompasses general educational purposes, values and aims. This knowledge includes issues about student learning, classroom management, lesson planning and implementation and student evaluation. It also includes knowledge of classroom techniques, the nature of the target audience, and strategies for evaluation (Mishra & Koehler, 2006: 1026).

Pedagogical content knowledge goes beyond knowledge of the subject matter only, it encompasses subject knowledge for the purpose of teaching. This knowledge includes an understanding of what makes the learning of specific topics easy or difficult and an understanding of the notions and presumptions students have about topics. If learners have misinterpreted certain topics, the teacher needs knowledge of the strategies that are necessary to reorganize the learners' understanding (Shulman, 1986: 9). Pedagogical content knowledge is knowledge that includes knowing what teaching approaches are suitable for the content and knowing how the elements of the content can be arranged for better teaching. This knowledge deals with the representations and formulation of concepts, pedagogical techniques, knowledge of what students bring to the learning situation; their strategies, prior conceptions, misconceptions they have about a certain field and misapplications of prior knowledge (Mishra & Koehler, 2006: 1027).

Technology knowledge is knowledge about standard technologies like books, chalk and the blackboard, the Internet and digital video. It is also concerned with the skills needed to operate certain technologies, which are constantly changing (Mishra & Koehler, 2006: 1027).

Technological content knowledge is knowledge about the way in which technology and content are related. Teachers need to have knowledge about the subject matter they teach, and also the way in which that subject matter can be adapted by applying technology (Mishra & Koehler, 2006: 1028). Technological pedagogical knowledge is knowledge of the existence, components and capabilities of different technologies as they are used in teaching and learning settings and having knowledge about how the use of particular technologies could change teaching (Mishra & Koehler, 2006: 1028). According to Mishra and Koehler (2006: 1029),

TPCK is the foundation of good teaching with technology and requires an understanding of the following aspects: representation of concepts using technologies, pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones.

The TPCK model which integrates technology in teaching and learning argues that in order to develop good content, all three sources of knowledge: technology, pedagogy and content, need to be thoughtfully interwoven (Mishra & Koehler, 2006: 1029). TPCK is the integration of the development of subject matter with development of knowledge of technology and of knowledge of teaching and learning. This integration of the different fields supports teachers in teaching their subject matter with technology (Niess, 2005: 510). Quality teaching requires a fine understanding of the relationships between pedagogy, content and technology, and using this understanding to develop appropriate strategies and representations. These components should not be viewed in isolation from the other, as this represents a real disservice to good teaching (Mishra & Koehler, 2006: 1029). According to Mishra and Koehler (2006: 1046), if teachers are given the opportunity to thoughtfully engage in the design of educational technology, they show growth in their sensitivity to the interactions among content, pedagogy and technology, thereby developing their TPCK. The comprehensive nature of the TPCK framework suggests the value of establishing learning environments where all three components are treated in an integrated manner and not as separate knowledge bases (Koehler *et al.*, 2007: 744). Technology should be taught in contexts that honour the rich connections between technology, the subject matter and the way in which it is taught (Koehler *et al.*, 2007: 758).

TPCK should be a critical outcome of teacher education, since it allows us to see the entire process of technology integration as being open to analysis and development work. The TPCK framework allows us to identify what is and is not important in discussions on teacher knowledge particularly when using technology for teaching subject matter (Mishra & Koehler, 2006: 1046). The TPCK framework also provides support for the use of real design-based activities for teaching technology by giving students the opportunity to learn in contexts that honour the rich connections between technology, the subject matter (content) and the way in which it is taught (pedagogy) (Mishra & Koehler, 2006: 1047). Mishra and Koehler (2006: 1025) represent TPCK graphically (Figure 2.1).

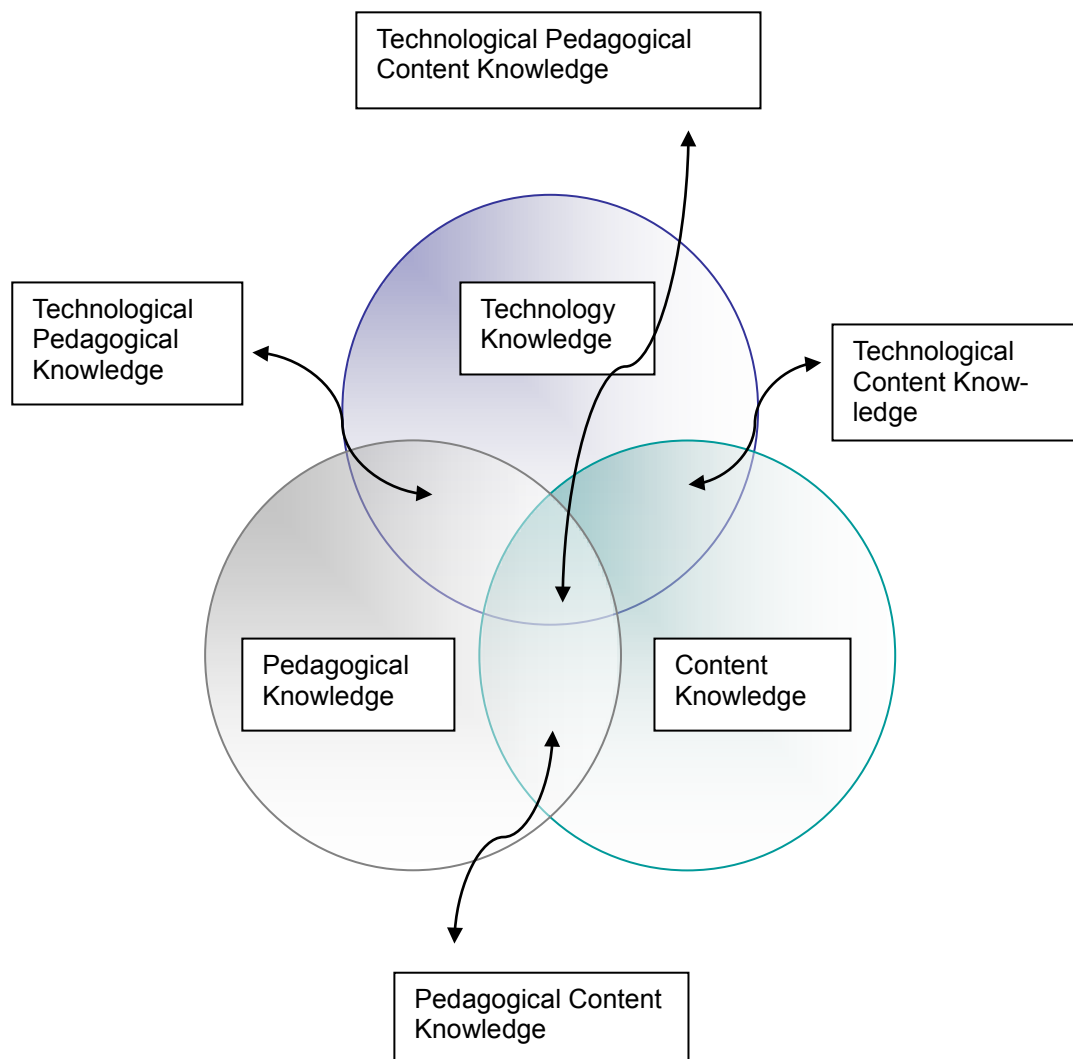


Figure 2.1 Representation of Technological Pedagogical Content Knowledge

Knowledge of technology, pedagogy and subject matter is an essential part of teacher education programmes to prepare pre-service teachers to teach using technology (Kocoglu, 2009:

2734). Teacher training programmes need to be carefully planned and applied in order to balance students' pedagogical and technological knowledge. The importance of understanding the three main components (technology, pedagogy and content knowledge) and their relationships cannot be underestimated (Erdogan & Sahin, 2010: 2707). Teacher education programmes are constantly challenged to prepare their students to integrate their knowledge structures, that is the intersection of knowledge of the subject matter with knowledge of teaching and learning, but there is also a need, especially for Mathematics and Science pre-service teachers to develop an overarching conception of their subject matter with regard to technology and what it means to teach with technology (Niess, 2005: 510). Good teaching with technology requires understanding the mutually reinforcing relationships between all three elements to develop context specific strategies and relationships (Koehler *et al.*, 2007: 741).

Niess (2005: 511) describes four central outcomes for the development of TPCK in a teacher education programme: (1) an overarching conception of what it means to teach a particular subject integrating technology in the learning; (2) knowledge of instructional strategies and representations for teaching particular topics with technology; (3) knowledge of students' understandings, thinking, and learning with technology in a particular subject; (4) knowledge of curriculum and curriculum materials that integrate technology with learning in the subject area. It is therefore essential to prepare teachers to integrate various technologies into their teaching; their knowledge and thinking should be directed in a way that considers the development of an overarching conception of teaching with technology (Niess, 2005: 511). Where Niess (2005: 511) believes that pre-service teachers need to be challenged to reconsider their subject matter content and the impact of technology on the development of the subject and the teaching and learning of the subject, so do I believe that in-service teachers face similar challenges.

Angeli and Valanides (2009: 157) criticize the work of Mishra and Koehler in that they suggest that it is uncertain whether TPCK is a distinct form of knowledge or whether it means growth in any of the related constructs (i.e. Pedagogical content knowledge, Technological content knowledge, Technological pedagogical knowledge or even the elements of Pedagogy, Content and Knowledge). The second point of criticism is that the boundaries between some components of TPCK are unclear, for example their definitions for Technological content knowledge and Technological pedagogical knowledge are indistinct. In the opinion of Angeli and Valanides, this creates a lack of precision in the framework. Their final point of criticism is that TPCK in its current form appears to be too general because it does not deal explicitly with the role of tool affordances in learning (Angeli & Valanides, 2009: 157). They

subsequently contribute to the further refinement of TPCK by introducing ICT-TPCK as a strand of TPCK. Their aim with the conceptualization of ICT-TPCK is to systematically address the precision that in their opinion is missing from the current conceptualization of TPCK regarding the relationship between content, pedagogy, and technology and to address issues related to the development and assessment of ICT-TPCK (Angeli & Valanides, 2009: 157).

ICT-TPCK is a strand of TPCK. It includes the three contributing knowledge bases, namely subject matter knowledge, pedagogical knowledge and technology (restricted to ICT) and two additional elements, namely knowledge of students and knowledge of the context within which learning takes place. The additional elements were included as a result of research done with in-service teachers (Angeli & Valanides, 2009: 158). This research revealed that while teaching with technology, teachers drew on their knowledge relating to their students' content-related difficulties; knowledge of what worked and what did not work in their classrooms; and how they believed they needed to teach to facilitate student learning (Angeli & Valanides, 2009: 158). ICT-TPCK is conceptualized as a unique body of knowledge that makes a teacher proficient in designing technology-enhanced learning. Angeli and Valanides (2009: 158) define ICT-TPCK as the ways knowledge about tools and their affordances, pedagogy, content, learners, and context are synthesized into an understanding of how particular topics that are difficult for learners to understand, or difficult for teachers to present, can be transformed and taught more effectively with ICT, in ways that signify the added value of technology. Technology is not merely a delivery vehicle that delivers information, but rather a cognitive partner that enhances student learning (Angeli & Valanides, 2009: 159). By developing Mathematics teacher students' TPCK, they are prepared for the current situation in the classroom, and also will have the knowledge and skills to work effectively in future classrooms (Erdogan & Sahin, 2010: 2711).

The Four in Balance Monitor is an annual publication of the Kennisnet Foundation which gives educators and other interested parties insight into the use and benefits of ICT in Dutch primary, secondary and vocational schools (Kennisnet, 2009: 6). The conceptual framework of this publication is taken from the four in balance model. They are of the opinion that in order to benefit from ICT use, there needs to be a balance between: (1) vision, (2) expertise, (3) the digital learning materials utilized and (4) the ICT infrastructure. In their opinion, it is only if these four conditions are in balance that ICT can offer real value (Kennisnet, 2009: 7). The benefits include the fact that both teachers and school managers are positive about the possibilities and benefits of ICT; ICT is suitable for offering subject matter in multiple ways; weaker pupils make progress when learning with the aid of ICT and most pupils enjoy working with ICT.

Kennisnet (2009: 12) presents a brief discussion of the four basic elements. Vision is the school's view of what constitutes good teaching and how they aim to achieve it. It involves the school's objectives, the role of the teachers and pupils, the teaching content and the materials that the school uses. The vision that the staff and manager adopt determines the school's policy and the design and organization of its teaching. Expertise is described as being sufficient knowledge and skills that teachers and pupils need to utilize ICT to achieve educational objectives. This involves not only basic ICT skills like operating a computer, but also pedagogical ICT skills if ICT is to be used to help design and organize learning processes. These additional skills are concerned specifically with the use of ICT to achieve educational objectives. Digital learning materials encompass all digital educational content both formal and informal. This includes computer programs. And lastly ICT infrastructure refers to the availability and quality of computers, networks, and Internet connections. Electronic learning environments and the management and maintenance of the school's ICT facilities are also considered to be part of this section. Although teachers play an important role in this process, however individual teachers cannot create this structure on their own. Support from the school's manager is also necessary. Figure 2.2 shows the elements of the Four in Balance Model as they relate to one another.

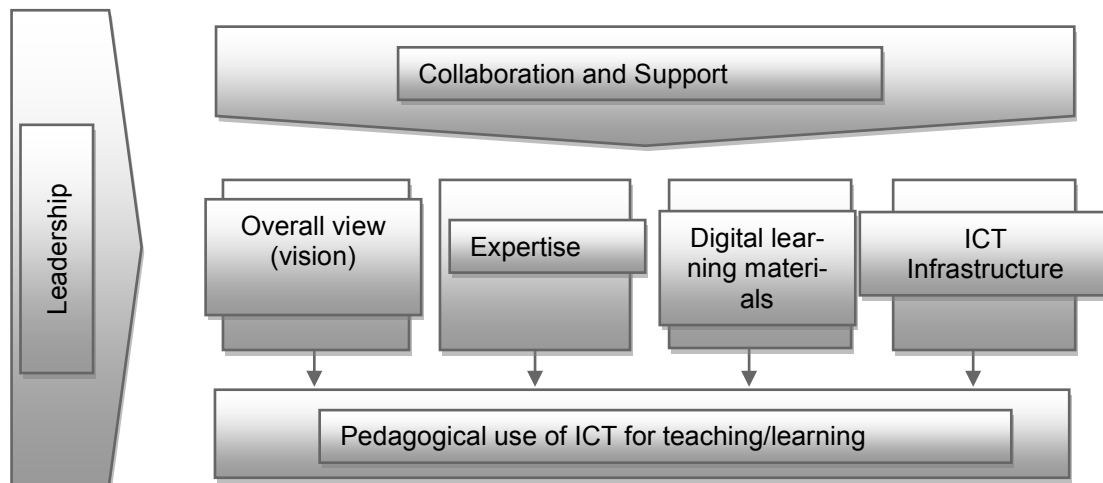


Figure 2.2: Four in Balance Model (Kennisnet, 2009)

The relevance of this model in this study is clear since the attitude of teacher-students towards ICT will be influenced by the school's vision. Expertise and Digital learning materials are required to allow the teacher-students to execute the use of ICT in any classroom and without the relevant infrastructure, implementation and use of ICT in South African schools will be impossible.

2.7 Chapter Summary

The prospective for digital technologies to enhance Mathematics learning cannot be denied, especially considering the challenges that Mathematics education faces. This chapter highlights what literature has to offer about the link between Mathematics education and ICT seen from the conceptual framework of the TPCK model and the Four in Balance Model. The influence that students' attitude has on various topics like anxiety, gender and computer experience was discussed as well as the factors that influence students' attitudes. It was fitting to also provide an exposition of the value of ICT, the effect thereof on pedagogy and the role that it plays in Mathematics education in both developing and developed countries.

Chapter Three

Research Design and Methodology

3.1 Introduction

The aim of this research was to answer the main research question: *What is the attitude of Mathematics teacher-students enrolled for the ACE in Mathematics course towards ICTs?*

This chapter addresses the research design and methodology used in this study, viewed from a structuralist approach. It addresses the researcher's choice of a quantitative research design which was executed in the form of a cross-sectional survey. This chapter furthermore concentrates on the specific research methods that were employed, including the selection of the population, the relevant variables, the data collection processes, the ethical aspects that needed to be taken into consideration and the data analysis procedures that were performed.

3.2 Lens of the Study

The world view or lens of this study will be from a structuralist view. This paradigm is embedded in a materialist view of the natural and social world and primarily aims at providing a critique of the current situation in social matters. This perspective aims to not only understand the world, but to change it (Burrell & Morgan, 1994: 326). The central notions that are prevalent to the radical structuralist paradigm are the notions of totality, structure, contradiction and crisis (Burrell & Morgan, 1994: 359). The study aims to describe and explain from a structuralist view what teacher-students' attitude towards ICT is. A quantitative research approach will be followed since in quantitative research you ask specific questions to obtain measurable and observable data on variables. The main statements and questions of direction in the study are specific and narrow and when studying these variables you obtain measures or assessments on an instrument (Creswell, 2005: 47).

3.3 Research Design and Methodology

In this section, the research design and methodology will be discussed.

3.3.1 Research Design

This study followed a quantitative cross-sectional survey design comprising a single mode research questionnaire to three groups of students in three countries.

3.3.2 Research Methodology

This section outlines the specific research methods that were used, including the instrument chosen for the research, the study groups that were selected, ethical aspects that were taken into consideration and how the data was managed and analysed.

3.3.2.1 Measuring Instrument

The questionnaire that will be used in this study is the Loyd and Gressard (1984) Computer Attitude Survey (CAS) with additional questions to meet the context and demands of the present study (Addendum 3.1). The questionnaire consisted of a 30-item version of the Computer Attitude Survey (CAS) which was developed by Loyd and Gressard rated on a five-point Likert scale (strongly agree, agree, neutral, disagree and strongly disagree) (Loyd & Gressard, 1984: 502). The higher the scores are, the more positive the attitude is to computers. The questionnaire presented statements of attitudes towards computers and the use of computers. These can be divided into three main types of attitudes: (i) anxiety or fear of computers; (ii) liking of computers or enjoying working with computers; and (iii) confidence in ability to use or learn about computers. The thirty items were selected by a panel of judges from an original pool of 78 items to represent each of the three attitude domains (Loyd & Gressard, 1984: 502).

The three sub-scales have been found to have good Cronbach's alpha reliability (Gressard & Loyd, 1986: 299). The coefficient alpha reliabilities were 0.86 for computer anxiety, 0.91 for computer liking, 0.91 for computer confidence and the total score 0.95 (Loyd & Gressard, 1984: 503). Although the researcher could not find a study in South Africa that made use of the entire Loyd and Gressard survey, a few studies made partial use of the survey or adapted it for their own purposes (Anthony *et al.*, 2000; Thatcher, 2008). This instrument has been used with numerous populations, including secondary students, teachers, college students and adults and has even been translated into Turkish and Hebrew (Francis *et al.*, 2000; Pamuk & Peker, 2009; Salzer & Burks, 2003). The attitude domains are therefore not culturally bound and language does not appear to play a role in the reliability of the instrument.

Section A of the questionnaire in the current study determined biographical detail of the participants as well as information regarding the participants' access to and time spent using computers at home and at work. Their accessibility to mobile phones and willingness to use both computers and mobile devices will also be questioned. In Section B the first 30 questions consist of the Loyd-Gressard computer attitude survey, the next twelve questions were included by the researcher. As is the case with many other researchers, these additional questions were included to make the questionnaire contextually valid. Most of the additional questions involved attitudes to Mathematics and one question involved more recent technology like cell phones and MP3 players.

The comparative nature of this study revealed similarities and differences in the students' computer and Mathematics anxiety, confidence and perceptions about the usefulness of computers and its usefulness in Mathematics across the three countries in South Africa, another Africa country, Tanzania and a developed country, namely Finland.

3.3.2.2 Variables

The dependent variable for this study was: The attitude of Mathematics teacher-students across three countries to computers. The independent variables were: Age of the students, gender, ownership of a computer, number of hours spent using a computer at home, access to a computer at school, number of hours spent using the computer at school, computer anxiety, computer liking, computer confidence.

3.3.2.3 The Role of the Researcher

The researcher is a lecturer at the SCTE at the NWU and works in the field of Mathematics education. Since there is always a need to improve student results and performances, especially in subjects like Mathematics, she decided to do this research project to determine the computer attitude of the Mathematics teacher-students primarily to have an idea of how they would feel about the inclusion of ICT in the mode of delivery. The research proposal was drafted and submitted to the Faculty for approval. The researcher completed the necessary ethical application and submitted it to the Ethical committee at the NWU to gain ethical clearance to proceed with the project.

The supervisor of the project, made the necessary arrangements with the deans at the different universities, so that when the ethical clearance was issued, she could begin collecting

data. The researcher collected data in Tanzania, and also created the link on the survey monkey website and made it available for the students in Finland to complete, and also posted the questionnaires to the relevant teacher-students in South Africa. As the data collection took place, recording also commenced. The researcher as well as the research assistant recorded all the data. Where necessary, the researcher managed the processes that the assistant followed and did regular spot checks to ensure accuracy. She also made sure that the data was stored securely and that all participants' identities were protected. The researcher plans to publish research reports from the research that has been carried out.

The data were augmented with photographs relating to the three research sites. These photographs belong to the researcher and the supervisor and therefore no copyrights were violated.

3.3.2.4 Population

A cross-sectional survey design was used to collect information from a purposive sample of Mathematics teacher-students (Fraenkel & Wallen, 2003: 397). The population(s) constituted all the ACE in Mathematics students at the North-West University (317 students), Mathematics education teacher-students at the Iringa University College, University of Tumbaini, Tanzania (111 students), as well as the Mathematics education teacher-students from the University of Eastern Finland, Joensuu, Finland (59 students). The population in this study consisted of:

- All students enrolled for an ACE (Advanced Certificate in Education) in Mathematics education at the School for Continuing Teacher Education of the North-West University, Potchefstroom campus, South Africa
- All students enrolled for Mathematics education as a major at the Tumbaini University, Iringa campus in Tanzania.
- All students enrolled for Mathematics education as a major at the University of Joensuu, Finland.

3.3.2.5 Ethical Aspects

The following ethical principles were applied throughout the project, namely that the participants were protected from any harm and the research data at all times remained confidential (Fraenkel & Wallen, 2003: 57). The necessary ethics application form were completed and submitted to the North-West University's ethics committee and permission were attained to commence the research (Addendum 3.2). Ethical clearance from the other two universities

was obtained. Permission from the relevant deans and staff of the faculties was also attained (Addendum 3.3 and 3.4). Each teacher-student was requested to complete a letter of consent, providing the researcher with permission to continue with the project. This letter ensured teacher-students that participation was voluntary, that they were free to withdraw from the project at any time, that withdrawal would not jeopardise their studies in any way, and that all information was treated as confidential. Since names were not required in the questionnaire, the identity of students remained anonymous. All results will be reported to the participating students and their respective institutions (Addendum 3.5 and 3.6).

3.3.2.6 Data Collection Procedure

A set of questionnaires which deals with the variables applicable to the students was completed by each group of students, i.e. in South Africa, in Tanzania and in Finland.

The bilateral collaboration agreement between the North-West University, Potchefstroom campus and the Iringa University College, University of Tumbani was signed by the rector of the North-West University at the time, Prof Combrinck and the provost of the Iringa University College, University of Tumbani, Prof Bangu in November 2008. This collaboration agreement encourages academic exchanges, programme development and research. The following activities are promoted between the two institutions:

- Exchange of teaching and research personnel and of students
- Cooperative development of courses and academic programmes
- Development of joint scientific research projects
- Cooperation in Master's and PhD degrees
- Any other activity of mutual interest regarding academic or scientific research matters.

The bilateral collaboration agreement between the North-West University, Potchefstroom campus and the University of Joensuu was signed by the campus rector of the North-West University at the time, Potchefstroom campus, Prof A Combrinck and the rector of the University of Joensuu, Prof Perttu Vartiainen in July 2008. The agreement promoted the same activities between these two institutions as listed above (Addendum 3.7 and 3.8).

The purpose of making use of these two collaboration agreements is to ensure the comparative nature of this study. The differences and similarities of the computer attitude of Mathematics education students in South Africa will be compared to those of Mathematics education students in a developing country, Tanzania and a developed country, Finland.

The supervisor of this study communicated with Prof Bangu the provost of the Tumaini University, Iringa University College, as well as Prof Matti Tedre and Dr Dan McIntyre regarding the researcher's visit to Iringa. Dr McIntyre put the researcher in touch with Mr Wilson Ntulo, the acting Head of Department Mathematics Education. The researcher contacted Mr Ntulo and explained the purpose of her visit to Tumaini University. Mr Ntulo made arrangements for the researcher to begin collecting data at Tumaini University.

The researcher travelled to Iringa in Tanzania to collect the data herself. The travelling expenses were funded by the staff development grant that the National Research Foundation (NRF) awarded to her. This grant was awarded because she is a full-time staff member of the North-West University, Potchefstroom campus and is currently studying towards a Masters degree under the supervision of Prof Seugnet Blignaut. All flights, accommodation and travelling expenses were covered by the above-mentioned grant. Professor Bangu, the provost of the Tumaini University, Iringa University College provided transport for the researcher from the nearest international airport, Dar Es Salaam to the town of Iringa. The researcher met with Mr Wilson Ntulo the acting head of department Mathematics education to discuss the research project and to arrange an appropriate manner in which the questionnaires could be administered to the Mathematics education students. After discussion and planning, it was decided to issue the questionnaires to the first year and third year Mathematics education students. The second year students were currently off-campus doing their practice teaching, which made them inaccessible at that moment.

An appropriate time was selected and the researcher and Mr Ntulo met with the students. The researcher was introduced to the two different groups of students at two different times. The first year students and the third year students were issued the questionnaire at two different times, as their academic timetable allowed. The researcher was introduced to each group of students and clear instructions were given concerning the procedure they needed to follow in order to complete the questionnaire. The researcher ensured that all information and instructions given to the two groups remained consistent. The students proceeded to complete the questionnaires. The researcher was present at all times and tried to make certain that the students provided answers to all the questions, to try to avoid any missing data. Data capturing began (Addendum 3.5).

Contrary to what was expected, the data collection in Finland was more complex than it was intended to be. The plan was to place the questionnaire on survey monkey, i.e. an online survey software and questionnaire tool in which surveys can be created and published in order to be completed online. The link for this website is <http://surveymonkey.com>. Results

are summarised by the survey monkey software and can be accessed by the researcher. The research proposal including the questionnaire was sent to the University of Joensuu for the relevant authorities to peruse in order to give ethical clearance for the Finnish students to complete the survey. Extensive communication took place between Prof Seugnet Blignaut and the authorities at the University of Joensuu. Due to some misunderstanding, some questionnaires were printed on paper and some students were asked to complete these, and some were completed online in survey monkey by the other students. With the assistance of Dr Tiia Koponen at the University of Joensuu, the paper copies were posted to South Africa. All the data were recorded in an excel spreadsheet (Addendum 3.6).

In order to work with the entire population and to cancel out the possibility of bias, the questionnaire and consent form was posted to all students enrolled for an ACE in Mathematics at the North-West University (Addendum 3.9). Each student's address was obtained from the administration system and envelopes containing a letter of consent, the questionnaire and an addressed return envelope were included in each envelope. Students were asked to complete this questionnaire at an appropriate time and return it to the researcher as soon as possible. In an attempt to ensure an acceptable return rate of the questionnaires, the teacher-students at the NWU were given the opportunity to win a mobile phone in a lucky draw if the questionnaires were returned within a certain time period. Reminders were sent via SMS to all students on three occasions to remind them of the closing date by which the questionnaires should have been returned. On the specified date, the lucky draw took place. Prof Spamer, director of the SCTE, performed the lucky draw. Figure 3.1 illustrates the draw that took place. The successful student was contacted telephonically and the mobile phone was sent via registered post to ensure safe-keeping. All other students were informed of the process and the winner via an SMS. The return rate for the questionnaires was 34.46% since 317 of the 920 were returned. Fifteen of the posted questionnaires were returned to the sender.



Figure 3.1 Prof Spamer Performing the Lucky Draw

The data was captured in an excel document. Each question on the questionnaire, Section A and Section B was allocated a variable. A spreadsheet was designed by the researcher that composed rows for each participant's information and columns that indicated the variables from v1 to v52. Data from each questionnaire was recorded on this spreadsheet. Where a Likert-type scale was used in Section A, the following ratings were used: 1 = very bad; 2 = bad; 3 = average; 4 = good; 5 = excellent. Other questions in Section A were coded as follows: Male = 1 female = 2; yes = 1; no = 2. In Section B, the Likert-type scale was rated as follows: 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree.

Data were captured by a research assistant. Each respondent's questionnaire was entered into the designed excel spreadsheet. Spot checks were done to ensure accuracy. Data were then sent to Dr Suria Ellis, from Statistical Services at the North West University, for analysis.

Staff members of Statistical Services made use of SPSS, Statistical Package for Social Sciences to analyse data. Descriptive statistics was used to answer the first sub-question: *What is the attitude of Mathematics teacher-students enrolled for the ACE in Mathematics course towards ICTs?* Factor analysis was done to identify relevant factors and was used to answer the sub-question: *To what extent are these students willing to use computers in their own studies as well as in the teaching process in their classrooms?*, and inferential statistics was used to answer the final sub-question: *What is the comparison of these attitudes with those of students in a developing and a developed country i.e. Tanzania and Finland?*

3.3.2.7 Data Analysis

Descriptive statistical techniques, reliability and validity of the instrument scale, inferential statistics (e.g. ANOVA), and cross-tabulations were used, and where appropriate, effect sizes were calculated. Descriptive statistics is a collective name for a number of statistical methods that are used to organise and summarise data in a meaningful way (Pietersen & Maree, 2007c: 183).

To determine what the attitude of the student-teachers was towards ICTs, they were asked to respond to the adapted Loyd and Gressard questionnaire (Loyd & Gressard, 1984). They were asked to rank their responses on a five-point Likert scale which consists of the following possibilities: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree. The mean of each response was calculated and describes the central location (arithmetic average) of the data, which implies in this context the average of the teacher-students' responses to each question. The standard deviation is a single number that represents the spread of a distribution. As with the mean, each score in the distribution is used to calculate it. The more spread out the scores were, the greater the deviation scores will be and the larger the standard deviation is. The closer the scores are to the mean, the less spread out the scores are and the smaller the standard deviation (Fraenkel & Wallen, 2003: 207).

Factor analysis was used to examine the construct validity of the instrument. The fundamental logic of factor analysis is that it is possible to statistically manipulate the empirical relationships among several indicators to reveal a common unobserved factor or hypothetical construct (Neuman, 1997: 170). The results of factor analysis tell a researcher how well the items relate to an underlying factor. It also produces factor scores which can be used as weights in creating an index. The scores represent how strongly each indicator is associated with the unobserved factor (Neuman, 1997: 170). Items measured on a five to seven-point Likert scale are well suited to this type of analysis. A factor analysis performed on a set of items produces a factor-loading matrix as its output. This is a matrix, which for each item, contains a loading on each factor. These loadings are correlations between the items and the factors and give an indication of which items belong to which factor (Pietersen & Maree, 2007b: 219). The factor loading matrix is produced by the factor analysis. Loadings greater than 0.40, which is an arbitrarily chosen cut-off value indicate the items that belong to the factors (Pietersen & Maree, 2007b: 221).

Once the factor structure has been confirmed, the internal reliability of each factor can be determined. When items are formulated to measure a certain construct, there should be a

high level of similarity among them. A measure of this degree of similarity is an indication of the internal consistency of the instrument. Cronbach's alpha coefficient is used to measure this internal reliability and is based on the inter-item correlations. If the items are strongly correlated with each other, their internal consistency is high and the alpha coefficient will be close to one, but if the items are poorly formulated and do not show a strong correlation, the alpha coefficient will be close to zero. The following figures for Cronbach's alpha coefficient are suggested and generally accepted by researchers: 0.90 – high reliability, 0.80 – moderate reliability and 0.70 – low reliability. Generally, reliability estimates of 0.80 are regarded as acceptable while values lower than 0.60 are regarded as unacceptable (Pietersen & Maree, 2007b: 216).

ANOVA is used when there are more than two independent groups that need to be compared on a single quantitative measure. It tests whether the groups have different average scores. ANOVA makes use of an *F-test* to detect significant differences. The test statistic (*F-value*) and the *p-value* are two important values produced by ANOVA, and are generally discussed by researchers when they discuss the outcome of an ANOVA (Pietersen & Maree, 2007a: 230).

3.4 Summary

In this chapter the research design and methodology were explored from a structuralist world view. The essential components of the research methodology were discussed in greater detail. The role that the researcher played in the research process was described, the selection of the measuring instrument was discussed, and the population and the ethical aspects were described. The procedures that were followed in the data collection process were presented and the data analysis techniques were described.

Chapter Four

Data Analysis and Addressing of Research Questions

4.1 Introduction

In this chapter, the responses of the three groups of student-teachers from North West University, South Africa, University of Joensuu, Finland and Iringa University College, Tumbaini University, Tanzania were analysed with the aid of SPSS™. Data were analysed with the assistance of the Statistical Consultation Services of the North West University.

The research question for this study is: *What is the attitude of Mathematics teacher-students enrolled for the ACE in Mathematics course towards ICTs?* In order to address the research question, the three sub-questions that are central to this study will be addressed separately. These sub-questions include: (i) What is the attitude of Mathematics teacher-students enrolled for the ACE in Mathematics course towards ICTs? (ii) To what extent are these students willing to use computers? and (iii) What is the comparison of these attitudes with those of students in a developing and a developed country i.e. Tanzania and Finland? In order to gain knowledge on these three issues, data will be presented in this chapter as a means of understanding the role of ICTs in student-teachers classrooms and their lives in general.

The first research sub-question, which is to determine the attitude of Mathematics teacher-students enrolled for the ACE in Mathematics course towards ICTs will be addressed by compiling a frequency table that records the average percentage response of the entire population on each question (Addendum 4.1). Relating concepts were discussed together to create a coherent picture of the student-teachers' responses to the questionnaire. These concepts will be discussed under a slightly adapted version of the three main subscales that were identified in the Loyd and Gressard survey, namely anxiety, liking and confidence. The researcher has expanded on the original concepts and discusses concepts like Mathematics confidence and liking, perseverance and a few other relevant concepts as well as the original themes computer anxiety, computer liking and computer confidence.

The second sub-question, which is to determine to what extent these students will be willing to use computers will be discussed by means of factor analysis and the third question, which is to compare these attitudes with those of students in a developing and a developed country i.e. Tanzania and Finland will be discussed in the light of the findings of descriptive statistics.

Descriptive statistics refers to summaries of data that is represented in three ways: through location (mean, mode and median), through dispersion (the range, variance and standard deviation) and through measures of shape (skewness or kurtosis) (Jansen, 2007: 19).

4.2 Validity and Reliability

The reliability and validity of the instrument will be discussed in this section. The demographic details of the student-teachers will also be presented.

4.2.1 Validity

A factor analysis was used to examine the construct validity of the instrument used in this investigation (the Computer Attitude Survey with additional items). The fundamental logic of factor analysis is that it is possible to statistically manipulate the empirical relationships among several indicators to reveal a common unobserved factor or hypothetical construct (Neuman, 1997: 170). The results of factor analysis tell a researcher how well the items relate to an underlying factor. It also produces factor scores which can be used as weights in creating an index. The scores represent how strongly each indicator is associated with the unobserved factor (Neuman, 1997: 170). Items measured on a five to seven-point Likert scale are well suited to this type of analysis. A factor analysis performed on a set of items produces a factor-loading matrix as its output. This is a matrix, which for each item, contains a loading on each factor. These loadings are correlations between the items and the factors and give an indication of which items belong to which factor (Pietersen & Maree, 2007b: 219). The factor loading matrix is produced by the factor analysis. Loadings greater than 0.40, which is an arbitrarily chosen cut-off value indicate the items that belong to the factors (Pietersen & Maree, 2007b: 221) (Table 4.1). The factors are described as follows: factor 1: perseverance; factor 2: lack of computer or Mathematics confidence; factor 3: computer or Mathematics anxiety; factor 4: attitude to problem-solving with computers; factor 5: self-perceptions about technology; factor 6: computer confidence and factor 7: Mathematics attitude.

Table 4.1 Computer Anxiety Scale

#	Question	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
22	I think using a computer would be very hard for me		0.358	0.251		0.281		
4	I feel aggressive and hostile towards computers			0.506				
1	Working with a computer would make me nervous			0.434				
14	I get a sinking feeling when I think of trying to use a computer			0.405		0.234		
30	It wouldn't bother me at all to take computer courses			-0.244				
23	I will do as little work with computers as possible			0.213				

As can be seen from Table 4.1 the Computer Anxiety scale of the Computer Attitude Survey has a three factor loading in this study. Only two items (14 and 22) are responsible for the three factors loading. All other items of the scale load on the same main factor. However, item 14 has a satisfying loading of 0.405 on the main factor, therefore validity can be assumed for this item. Item 22 has an unsatisfactory 0.251 loading on the main factor, therefore results of this item will be cautiously interpreted as part of this scale. Overall, validity can be assumed for this scale because most items load satisfactory on the main factor.

Table 4.2 Computer Confidence Scale

#	Question	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
8	Computers make me feel uncomfortable					0.381	0.236
29	I have a lot of self-confidence when it comes to working with computers	0.205				-0.334	-0.267
16	I would feel comfortable working with a computer						-0.593
11	I think working with computers would be enjoyable and stimulating						-0.555
10	I would feel at ease in a computer class				0.201		-0.466
15	I am sure I could work with computers	0.338				-0.258	-0.400
2	I would like working with computers						-0.399
9	Generally I would feel OK about trying a new problem on the computer						-0.399

As reflected by Table 4.2, the Computer Confidence scale of the Computer Anxiety Survey has a four factor loading in this study. Four items (8, 10, 15 and 29) are responsible for the four factors loading. All other items of the scale load on the same main factor. However, items 10 and 15 have a satisfying 0.466 and 0.400 loadings on the main factor, therefore validity can be assumed for these two items. Items 8 and 29 have an unsatisfactory 0.236 and

-0.267 loadings on the main factor, therefore results of these two items will be cautiously interpreted as part of this scale. Overall, validity can be assumed for this scale because most items load satisfactory on the main factor.

Table 4.3 Dislike of Computers and Mathematics Scale

#	Question	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 8
19	I don't understand how some people can spend so much time working with computers and seem to enjoy it							-0.626
39	I don't understand how some people seem to enjoy spending so much time on maths problems							-0.589

A factor analysis was conducted on the third CAS scale, i.e. Computer Liking. Unsatisfactory multiple factor loadings were calculated. For the purpose of this investigation, two negative items (19 and 39) were identified which has a single factor loading (Dislike of Computers). In Section 4.4 and Table 4.17 the researcher conducted her own factor analysis on all items of the CAS questionnaire with additional items. From this factor analysis, new themes (main factor loadings) were identified, with good validity and reliability indices (Tables 4.17 and 4.18), which were further grouped under two meta-categories, i.e. barriers and enablers (Table 4.19).

4.2.2 Reliability (Internal Consistency)

Internal reliability refers to the extent to which causal conclusions can be drawn (Maree & Westhuizen, 2007: 39). The Cronbach alpha coefficient is used to measure the internal reliability and is based on the inter-item correlations. If the items are strongly correlated with each other, their internal consistency is high and the alpha coefficient will be close to one, but if the items are poorly formulated and do not show a strong correlation, the alpha coefficient will be close to zero. The following figures for Cronbach's alpha coefficient are suggested and generally accepted by researchers: ≥ 0.90 (high reliability), 0.80 (moderate reliability) and ≤ 0.70 (low reliability). Generally, reliability estimates of 0.80 are regarded as acceptable while values lower than 0.60 are regarded as unacceptable (Pietersen & Maree, 2007b: 216).

Table 4.4 Cronbach's Alpha Coefficient (Reliability)

Subscales	Loyd and Gressard (1984: 503)	Francis (2000: 153)	Current Study 2010
Computer anxiety	0.86	0.84	0.60
Computer liking	0.91	0.88	0.555*
Computer confidence	0.91	0.85	0.85

* Indicates the Factor dislike of computers and Mathematics

Table 4.4 compares the Cronbach alpha reliability indices calculated for the scales of the CAS for the current investigation with the reliability indices reported by Loyd and Gressard CAS in their original 1984 study, as well as with the reliability indices reported by Francis *et al.* (2000) in their study in which the CAS was translated into Hebrew. As can be seen from Table 4.4 the current investigation reports a similar good internal consistency (reliability) for the Computer Confidence scale (Cronbach alpha 0.85). However, low reliability indices were found for the Computer Anxiety scale (0.6 Cronbach alpha coefficient) and the Computer Liking scale (Cronbach alpha value of 0.555). A possible reason for the unfavourable internal consistency of these scales is that English is a second or third language for the three groups of participants in this study. Van der Walt (1997), as well as Els, Van Eeden and Du Plessis (2010), found that South African respondents would rather surmise or speculate on difficult statements, than indicate that they do not comprehend the true meaning of English terms. Reliability of the Computer Confidence scale can therefore be assumed for the study population of this investigation. Results of the combined Computer Anxiety and Computer Liking scales will be cautiously interpreted.

As already indicated, the researcher conducted her own factor analysis and internal consistency tests on all items of the CAS questionnaire with additional items (§ 4.4, Tables 4.17 and 4.18). New themes (main factor loadings) were identified, with satisfying validity and reliability indices (Tables 4.17 and 4.18), which were further grouped under two meta-categories, i.e. barriers and enablers (Table 4.19).

4.2.3 Demographics

The demographic details of the teacher-students in the three countries will be presented in this section.

Table 4.5 Summary of the Demographic Information of Teacher-students

Aspect	South Africa		Finland		Tanzania	
	Male	Female	Male	Female	Male	Female
Gender	170	147	20	39	98	13
Ownership of a computer at home	137	180	59	0	77	33
Ownership of a mobile phone	276	38	58	1	108	2
Access to a computer at university	44	262	57	1	102	8
Willingness to do Mathematics on a computer	316	2	29	28	108	3
Willingness to do Mathematics on a mobile phone	290	27	17	41	89	21

The gender distribution between the three countries was interesting. In Finland, there were more females than males that responded to the questionnaire, but in both South Africa and Tanzania, the number of males exceeded that of the females. Eighty eight percent of the Tanzanian population was male and there was a mere 12% female representation. This might be due to the fact that the females find it difficult to study and cope with the responsibility of children and a family, considering that the average age of the Tanzanian students was 30.7 as opposed to the average age of the Finnish students at 22.4 years. At this young age, the responsibilities of children and family most likely do not rest on the shoulders of the women in Finland. The South African teacher-students face a similar scenario as the Tanzanians. The number of males in the South African population is greater than that of the females, and keeping in mind that the average age for the South African teacher-students was 42.2 years, a similar argument about family obligations might be presented as a reason for the lower numbers of women who study. The other possible reason could be that as in many other studies, the influence of gender on computers and Mathematics could imply that less women enrol for these courses (Bovee *et al.*, 2007; Meelissen & Drent, 2008; Volman *et al.*, 2005). Table 4.6 summarises the age distribution of the population.

Table 4.6 Age Frequency Distribution Table

Age	Frequency	%
20-25	64	13.3
26-30	44	9.2
31-35	72	14.9
36-40	115	23.9
41-45	87	18.1
46-50	66	13.7
50+	33	6.9

The ages were divided into class intervals and the frequency of each class interval as well as the percentage that each class represents has been given in Table 4.6. The class interval with the highest representation as a percentage is the 36 to 40 year old group. The next interval 41 to 45 is the next highest representation with 18.1%. Figure 4.1 summarised the ages of the teacher-students.

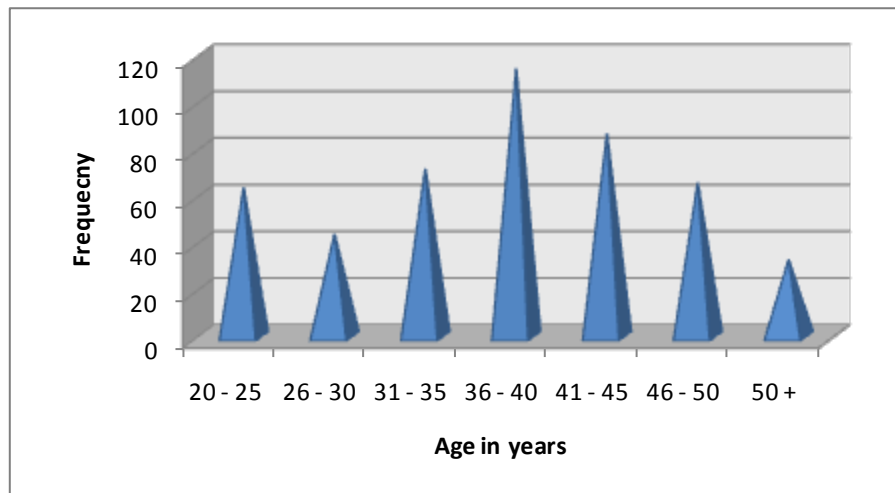


Figure 4.1 Frequency Distribution of Ages

There were 115 teacher-students out of a total of 488 that fell into the class interval of 36 to 40 years of age. It is interesting to note the slight decline in numbers of teacher-students in the class 26 to 30 years old. This might be due to an inflated amount of 20 to 25 year olds who are studying in Finland. The average age of the Tanzanian students was 30.7 years, the Finnish students was 22.4 years and the South Africans was 42.2 years. Figure 4.2 represents a contact session at one of the centres of the SCTE. Here is evidence that many teacher-students fall in the interval between 41 and 45 years of age.



Figure 4.2 Teacher-students at a Contact Session at Empangeni, South Africa

Of interest is that at the North-West University in South Africa, the entrance requirement for the ACE course is that candidates need to be in possession of an approved after-school qualification of three years. This would mean that average ages would probably be higher than

the 20 to 25 classification. These teacher-students are also in-service students which means their ages are likely to be higher than the average pre-graduate student.

4.3 Attitude of Mathematics Teacher-students

In order to determine the attitude of teacher-students in the given population toward ICT's, certain questions in the questionnaire relate to the same concepts and the researcher has grouped them together. The issues that arise were: anxiety towards computers, confidence with computers, liking computers, willingness to do advanced computer work, perseverance in computer issues, problem solving and the influence of affective factors on computer use, Mathematics anxiety, confidence with Mathematics, liking Mathematics, attitude to new technology. When reporting on the frequencies, the percentage response for the two combined columns have been added together, rounded off and recorded. The frequencies of all the results were captured in Addendum 4.1.

It is important to keep in mind that English is not the primary language spoken at home in South Africa, Tanzania or Finland. Although English is an official language in South Africa, ten other official languages dominate and language remains an obstacle (Anderson & Plomp, 2008: 53). The negative effects of this language barrier is that not only are questionnaires not always properly understood, but when dealing specifically with ICT, English is the most commonly used language on the World Wide Web, which creates additional problems and even anxiety. Figure 4.3 is an example of a group of Mathematics students in Tanzania. English is not their first language, which accentuates the problem of English communication.



Figure 4.3 Mathematics Student-teachers in Tanzania

4.3.1 Anxiety

The anxiety subscale will be discussed under the following sections: anxiety towards computers, Mathematics anxiety and the influence of affective factors on computer use.

4.3.1.1 Anxiety towards Computers

Before considering the factor analysis, the researcher made use of descriptive statistics to identify and interpret various issues which relate to the attitude of the Mathematics teacher-students. These issues include anxiety, liking and confidence. Although literature offers a variety of definitions for computer anxiety (Baloglu & Cevik, 2008: 2640; Ceyhan, 2004: 208), there appear to be a number of terms and ideas that are regularly associated with the concept of computer anxiety. These include: a fear component; computer-phobia; computer apprehension and technophobia (Baloglu & Cevik, 2008: 2640). One of the many definitions offered does seem to capture the essence of computer anxiety that relates to a negative emotional state or negative cognition experienced by individuals when they use computers or computer equipment (Bozionelos, 2001: 956). Some definitions even indicate that there might be fear and apprehension felt when even considering the use of a computer (Beckers *et al.*, 2001: 2852).

Various studies have focused on the effect of computer anxiety. Some research on computer anxiety suggests that there is an interrelationship between computer use, ease of use, perceived usefulness and behavioural intentions. The implication is that attitude toward computers and self-efficacy has a direct effect on perceived usefulness (Hsu *et al.*, 2009: 419). Gender is one of the most studied variables in research about computer anxiety. A study that investigated the effects of gender, ownership and the frequency of computer use on computer anxiety levels revealed a significant covariate effect of trait anxiety and use of computers on computer anxiety (Baloglu & Cevik, 2008: 2639). A review of the literature shows that in general males appear to be less anxious than females, but this trend seems to be changing as there is a fair degree of inconsistency in the findings. Baloglu *et al.* (2008: 2646) suggest that nowadays men (or women) might experience anxiety differently than men (or women) who lived some time ago. Their study is concerned with gender differences in an era when computers are more part of our daily lives than they ever were previously. Their findings are that girls have higher levels of computer anxiety than boys. Figure 4.4 appears to reveal that the majority of the teacher-students at NWU are females, but when analysing the returned questionnaires, this was not the case. Such assumptions cannot be made since

there is an array of other variables that play a role like gender differences in: class attendance, returning of questionnaires and those teacher-students that major in Mathematics.



Figure 4.4 Teacher-students at the Potchefstroom Campus, NWU in South Africa

In the present study, the percentage of male teacher-student respondents was 59% and females 41%. This is in agreement with the research mentioned above, since the low levels of anxiety could be assigned to the fact that almost 60% of the group was male. The South African group constituted 54% males and 46% females.

Computer anxiety was addressed in seven questions, three were phrased positively and four were phrased negatively. Questions 3, 5 and 10 were questions that were positively phrased (Table 4.7). They all received a high rating in the agree column on factors such as feeling at ease in a computer class (78%), computers do not scare them (81%) and they do not feel threatened when others talk about computers (80%).

Table 4.7 Positive Indicators of Computer Anxiety

	Question	Disagree	Neutral	Agree
3	Computers do not scare me at all	10%	10%	81%
5	I do not feel threatened when others talk about computers	13%	7%	80%
10	I would feel at ease in a computer class	12%	15%	78%

Four additional questions (1, 8, 22 and 24) also related to computer anxiety, but in this case the statements were negatively phrased, upon which the majority of the responses fell in the disagree column which implied that the student-teachers did not show high anxiety levels towards computers. The results are summarised in Table 4.8. Factors that arose here were:

working with computers make me nervous which has a 74% rate of responses that disagree; *computers make me feel uncomfortable*, 90% disagree, *I think using a computer would be very hard for me* has a 91% disagree rate and *computers make me feel uneasy and confused* had a 89% disagree rate. This supports the results of the four questions listed above which implies that the teacher-students did not show high levels of anxiety when it comes to working and dealing with computers.

Table 4.8 Negative Indicators of Computer Anxiety

Question		Disagree	Neutral	Agree
1	Working with a computer would make me nervous	74%	13%	13%
8	Computers make me feel uncomfortable	90%	5%	5%
22	I think using a computer would be very hard for me	91%	5%	4%
24	Computers make me feel uneasy and confused	89%	6%	4%

This provides many opportunities for the delivery mode of educational institutions, especially those involved in distance education. The need for blended learning is becoming greater and if the teacher-students are ripe and ready to make use of technology, the possibilities of providing functional and relevant student support are endless. In a study done at the SCTE on ACE teacher-students doing an ICT course, only 5.6% claimed to be afraid of computers, 88% of the sample indicated that they were not afraid of computers (Blignaut *et al.*, 2010). These results support the findings of this study.

Where some research has determined that personality variables significantly affect computer anxiety (Ceyhan, 2004: 218), Beckers *et al.* (2001: 2852) established a distinction between whether computer anxiety is a predominantly temporary state which emerges while being confronted with a computer or whether it is a stable trait of an individual, which by implication forms part of a broader anxiety disorder. The importance of making this distinction impacts on the treatment of computer anxiety. As could be expected, a temporary anxiety will subside, and special training or increased exposure to computers could reduce this type of anxiety, while a trait-type anxiety will be more difficult to treat, since the source of the anxiety is more deep-seated. The results of their study showed that computer anxiety is based on trait anxiety, which makes treatment of the problem much more complex. This study involved questionnaires that were given in paper and pencil format and also computer versions. After in-depth statistical analysis they were able to conclude that not only is computer anxiety correlated with trait anxiety, but also in the presence of the computer, computer anxiety clearly affects state anxiety.

In the light of this study mentioned above, it would be interesting to establish what influence the mode of delivery of the questionnaire has on the population of my study. The majority of the questionnaires were presented in a paper and pencil format, therefore in the absence of any form of a computer. Perhaps the low levels of anxiety expressed by the student-teachers could be a reflection of their lack of state anxiety, due to the physical absence of computers, as described by Beckers' work.

4.3.1.2 Mathematics Anxiety

Mathematics anxiety is not a new phenomenon in society. To many people Mathematics is the unknown, the unfathomable. Various studies have shown that Mathematics anxiety is a widespread problem for students (Jain & Dowson, 2009: 240; Ma & Xu, 2004: 166). Part of the problem concerning Mathematics anxiety is that teachers are not equipped to correctly deal with learners that are affected and their fear then in turn affects academic success (Ruffins, 2007: 17). Mathematics anxiety has been described as the state of nervousness and discomfort brought upon by the presentation of mathematical problems and is known to hinder Mathematics performance regardless of the person's actual ability (Ashcroft & Moore, 2009: 197). Some characteristics of this anxious state include symptoms like tension, frustration, distress, helplessness, nervousness before class, panicking and going blank during a test (Ma & Xu, 2004: 165; Ruffins, 2007: 17). Teachers play a pivotal role in retarding and reducing the anxiety levels of their learners. It is therefore essential in teacher training programmes to educate teachers on how to reduce learners' levels of Mathematics anxiety (Zientek *et al.*, 2010: 436). According to the results of the two questions listed in Table 4.9, the student-teachers did not show indicative signs of Mathematics anxiety.

Table 4.9 Indicators of Mathematics Anxiety

#	Question	Disagree	Neutral	Agree
37	I find Mathematics frightening	84%	8%	8%
41	I find Mathematics confusing	83%	8%	9%

Since reduced anxiety is the desired outcome, the indication that 84% of the students do not find Mathematics frightening or confusing (83%) is encouraging information. The link between Mathematics anxiety and Mathematics achievement has undoubtedly been made in literature reviews (Ashcroft & Moore, 2009: 204; Ma, 1999: 536; Ma & Xu, 2004: 176), so the lack of Mathematics anxiety will hopefully result in higher achievement.

4.3.1.3 Influence of Affective Factors on Computer Use

In Psychology, positive affect refers to positive emotions and feelings, while negative affect refers to negative emotions and feelings (Kammann & Flett, 1983). Affective factors are emotional factors which not only influence psychological and emotional well-being, but have a direct influence on learning (Fredrickson, 2001). Research on affect shows human emotions to be discrete and cross-culturally understood (Ekman *et al.*, 1987).

A person's attitude to computers is defined by their feelings of favourableness or unfavourableness towards computers and computer-related activities (Kay, 1993: 233). Various computer attitude surveys include a component to specifically test the user's emotion or feeling concerned with how much the computer is liked. The behavioural component of the attitude relates to what the individual does or intends to do with the technology (Kay, 1993: 233). Although the CAS does not specify which components measure affective factors, there are sufficient questions that relate to emotional issues and how they influence the user's attitude to computers. Not only do affective factors influence computer attitude, they also play an important role in the learning of Mathematics. Literature presents an assumption that still needs further investigation, and that is that positive Mathematical beliefs, attitudes and feelings will lead to increased Mathematical achievement (Grootenboer & Hemmings, 2007: 3). Table 4.10 highlights four of the questions that relate to emotional issues that could have an impact on computer attitude.

Table 4.10 Indicators of Affective Factors

Question		Disagree	Neutral	Agree
4	I feel aggressive and hostile towards computers	77%	12%	12%
14	I get a sinking feeling when I think of trying to use a computer	83%	9%	8%
16	I would feel comfortable working with a computer	3%	5%	92%
18	I'm not the type to do well with computers	76%	14%	11%

These four questions addressed emotions like feeling aggressive, getting a sinking feeling, feeling comfortable, perceptions of the type of person you are. All were phrased negatively except *I would feel comfortable working with a computer* which averaged to 92% Agree. The other questions ranked highly in the Disagree column which implied that the students' affective factors did not negatively influence their computer use or their attitude to computers. Figure 4.5 illustrates the degree to which emotional factors positively influence the teacher-students' experiences with computers.

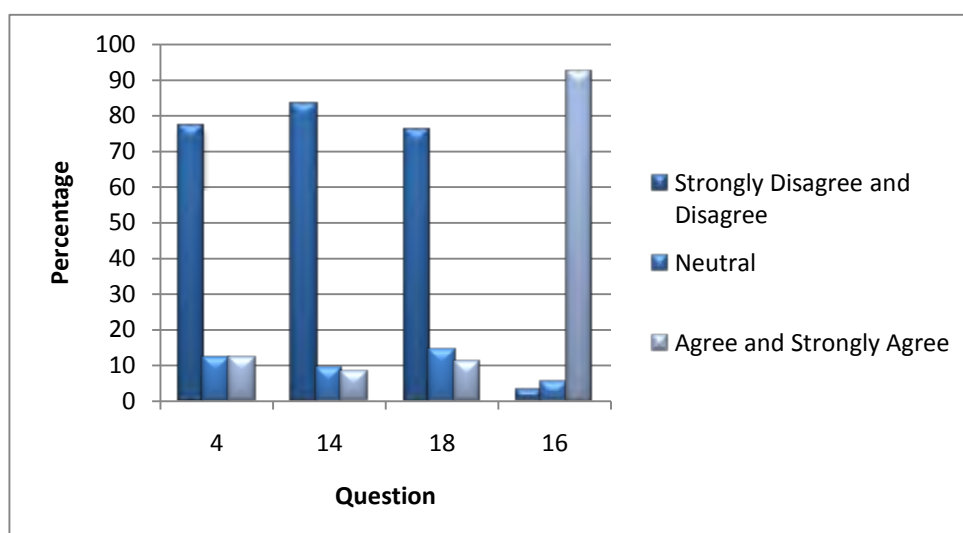


Figure 4.5 Positive Influence of Affective Factors on Teacher-students Computer Use

SITES 2006 reported on the teachers' personal characteristics and their perceptions of a number of contextual factors, and how they influenced their use of ICT in teaching. Although teacher age and gender showed significant effects in certain systems, no consistent pattern emerged regarding these characteristics. The second personal characteristic that was investigated is that of teacher qualifications. In general teachers with higher academic qualifications were those most likely to use ICT, and finally, teachers' pedagogical ICT competence was the best positive predictor of teachers' pedagogical ICT use (Law & Chow, 2008: 217).

4.3.2 Liking

The second subscale of liking will be discussed under the following sections: computer liking, Mathematics liking and perseverance during computer use.

4.3.2.1 Liking Computers

Computer liking refers to a person's positive feeling and thoughts towards computers and use of computers. Computer liking does not appear to be a significant factor in relation to computer anxiety, despite the ever-presence of computer applications in society. Many people may have positive feelings (like computer liking), yet this is not important to user perception of the task (Chang, 2005: 715). In a Turkish study which investigated computer attitudes of Science and Mathematics teacher candidates, it was found that males like computers more than females, although their levels of anxiety and confidence in using computers and their beliefs in the usefulness of computers did not differ (Pamuk & Peker, 2009: 459). Figure 4.6 represents the results of the secondary biographical questions in the questionnaires.

They were all dichotomous questions in which the possible answers were yes or *no*. These results provided the researcher with information about the teacher-students' willingness to use technology.

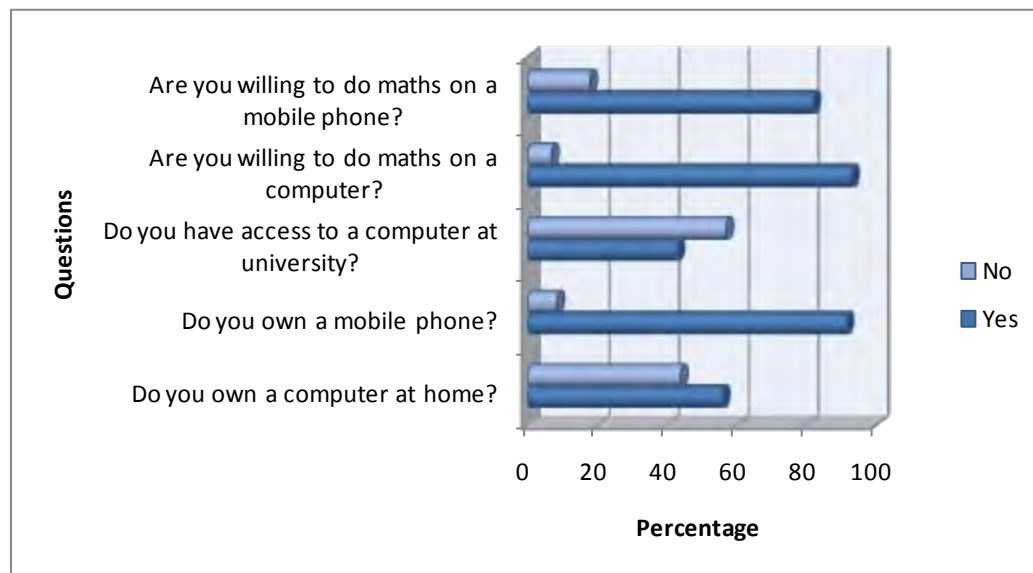


Figure 4.6 Representation of the Teacher-students' Access to and Willingness to Use Technology

Howie and Paterson (2005: 13) report that according to the school register of needs survey done in 2000, less than 60% of schools in South Africa have provision of electrical power. She also reports from the same survey that access to telephones has increased from about 40% in 1996 to about 65% in 2000. This she attributes to the increased accessibility of mobile telephones. The percentage of students in this study that have access to a computer at home is 56% and at their university is 43% (Figure 4.3). These results can be confirmed by a study done at the SCTE with a group of students who do an ICT module in the ACE programme. Almost 60% of the population agreed to having easy access to a computer, although only 29% have easy access to reliable Internet. Also 54% frequently use computers and 58% use computers with ease (Blignaut *et al.*, 2010). In Figure 4.7, one of the available resources at a contact centre of the SCTE is illustrated. Computers and the Internet are available for teacher-students to use at all contact centres across South Africa.



Figure 4.7 Computers and Internet are Available for Teacher-students at all Outside Centres of the SCTE, NWU

As is evident in Figure 4.6, the teacher-students in this study had a phenomenal access rate to mobile phones of 91.5%, and even more encouraging was their willingness to use those mobile phones in pedagogic activities like doing maths on a mobile phone. The percentage of teacher-students that were willing to use a mobile phone to do Mathematics was 80%. Even more heartening was the number of student-teachers willing to do Mathematics on a computer at 93%. This is a strong indicator that student-teachers have a positive attitude to technology and are willing to be involved in technology use for Mathematics education. Although Tanzania does not have an extensive mobile phone network, there are visible signs, as illustrated in Figure 4.8 of an ever-improving infrastructure for increased access to technology.



Figure 4.8 Infrastructure for the Increased Use of Mobile Phone Access in Tanzania

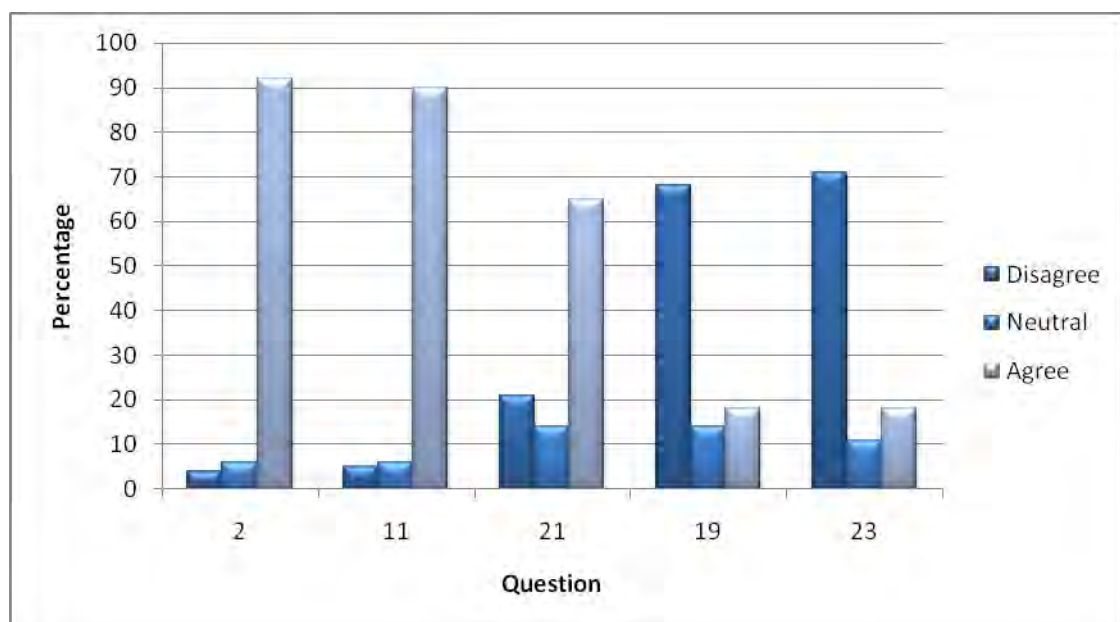
Literature reveals a range of factors that influence Mathematics achievement such as accessing ICTs, using computers at home or at school and socio-economic status. According to Thomson *et al.* who report on the results of PISA 2003 (Programme for International Student Assessment), when teachers used computers in training materials in Mathematics, students understood the Mathematics better than the other lessons (Thomson & Bortoli, 2007: 14).

Two questions were strongly connected to student-teachers' liking computers (Table 4.11). They are *I would like working with computers* (92% Agree and Strongly Agree) and *I think working with computers would be enjoyable and stimulating* (90% Agree and Strongly Agree). These questions almost sketch a picture of not only the fact that those who do have access to computers do enjoy working with them, but a perceived/predicted enjoyment for those who do not have access at all or who have little or irregular access. These two questions above might also express some students', especially those in rural areas who might not even have electricity, desire to want to interact more with the computer, if given the opportunity.

Table 4.11 Indicators of Computer Liking

	Question	Disagree	Neutral	Agree
2	I would like working with computers	4%	6%	92%
11	I think working with computers would be enjoyable and stimulating	5%	6%	90%
19	I don't understand how some people can spend so much time working with computers and seem to enjoy it	68%	14%	18%
21	Once I start to work with a computer, I would find it hard to stop	21%	14%	65%
23	I will do as little work with computers as possible	71%	11%	18%

Although the latter three questions were not as strongly convincing as the first two, they yet indicated a predominantly positive liking to computers. *I don't understand how some people can spend so much time working with computers and seem to enjoy it* scores 68% on the scale of strongly disagree and disagree; *Once I start to work with a computer, I would find it hard to stop* has an average of 65% Agree and *I will do as little work with computers as possible* scores 71% on Disagree. The implication being that they to a large extent did like working with a computer. Twenty one percent of the students did not find it hard to stop working with a computer. Many external factors that may have played a role here were time constraints of those that were full-time teachers as well as students, and family and societal obligations that demanded much of their time. Figure 4.9 indicates high agree levels for the questions that are related to student-teachers' liking computer, which are positively phrased and high disagree levels for those that are phrased negatively, but still indicate positive computer liking.

**Figure 4.9 Comparison of Questions relating to Computer Liking**

Although in general from this information, it appears that student-teachers were positive about using computers and appeared to like using them, we should take cognisance of ob-

stacles to the integration of ICTs that have been identified in previous studies. When analysing the results of SITES 1997, Pelgrum (2001: 174) noted that some of the frequently mentioned problems in ICT implementation include insufficient number of computers, teachers lacking knowledge and skills and not enough computers with simultaneous access to the world wide web. These factors all play a role in teachers' ultimate attitude towards and use of computers.

4.3.2.2 Mathematics Liking

Not only was the level of computer liking investigated, but also Mathematics liking. Figure 4.10 indicates four questions that relate to Mathematics liking and once again the overall picture presented is that of positive Mathematics liking.

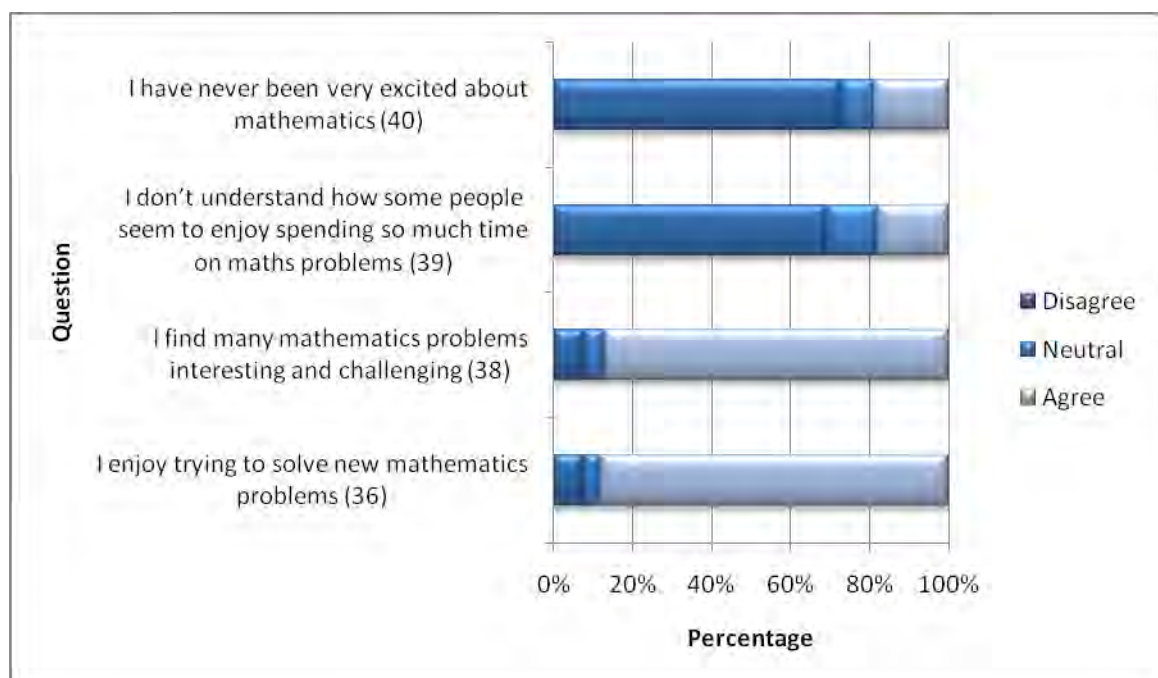


Figure 4.10 Mathematics Liking

The majority of the population found Mathematics problems interesting and challenging (88%) and enjoy trying to solve new Mathematics problems (89%). The other two questions, also indicate a positive liking for Mathematics: *I have never been very excited about Mathematics*, 73% disagree and *I don't understand how some people seem to enjoy spending so much time on Maths problems*, 69% disagree. These factors play an essential role in the attitude that the teacher-students have to ICT.

4.3.2.3 Perseverance during Computer Use

The contextual factors of the teacher-students in South Africa vary to a large extent, however many students live in rural areas with little or no infrastructure. The fact that these student-teachers are willing to not only use computers, but show definite signs of perseverance in their computer use is phenomenal. Figure 4.11 illustrates a group discussion at a contact session at one of the tuition centres of the SCTE. There is often limited classroom space and facilities available to use, but what is evident is the eagerness with which the teacher-students attend and participate at these contact classes.



Figure 4.11 Teacher-students at the Tuition Centre in Ermelo, South Africa

The context in Tanzania is very similar to that in South Africa, perhaps even more debilitating. In Tanzania, the infrastructure for ICT is not well developed. There is no strong Internet support system but a number of unconnected systems owned by different companies. The distribution of electricity is sparse and unreliable and in many areas the electrical network and transformers are overloaded and work to full capacity. The landline communication network is sparse and the mobile phone network is far from being extensive. Building contractors and electricians lack knowledge of the infrastructural requirements of modern computing and communications equipment and the absence of an extensive network of experts who are available to take care of technical problems in specialised fields (Tedre *et al.*, 2009: 102). Figure 4.12 shows one of the lecture halls at Iringa University College, University of Tumaini, Tanzania.



Figure 4.12 Context in which Learning takes Place in Tanzania

Factors that are usually not a concern in industrialised countries, like extreme poverty, the post-colonial condition and tribal traditions have a huge effect on the pedagogical approach in Tanzania (Tedre *et al.*, 2009: 106). In contrast to the context of Tanzanian education, Figure 4.13 illustrates a typical university building in a developed country, in this case the University of Joensuu in Finland.



Figure 4.13 One of the Buildings at the University of Joensuu, Finland

Finland has since 1998 been able to provide 100% of the schools that have Grade 8 learners with access to computers. SITES 2006 reports that the number of schools in Finland that provide Internet access to learners increased from 96% in 1998 to 100% in 2006 (Pelgrum, 2008: 75). Also, in Finland, a mere 5% of the school principals considered ICT very important for improving the performance of learners. Pelgrum (2008: 72) believes this could be related to the number of years that schools had been using ICT, but this still needs to be confirmed. Figure 4.14 illustrates the perseverance that teacher-students have especially in a computer problem-solving situation.

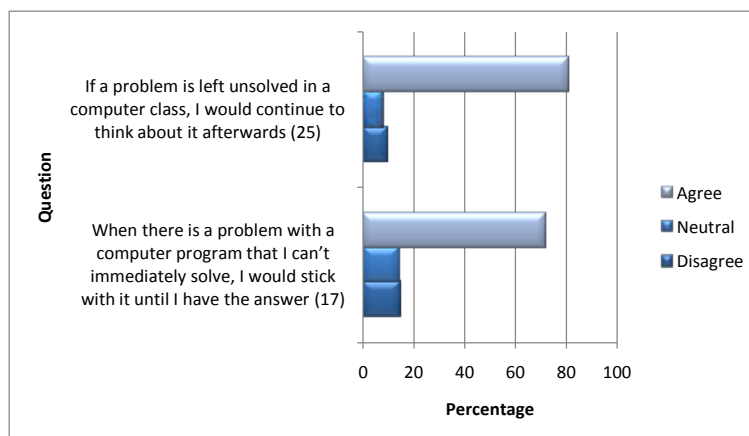


Figure 4.14 Indicators of Perseverance

In the light of these obstacles and barriers to learning, the population still indicated high levels of perseverance during computer use. According to the results presented in Figure 4.14 the student-teachers showed high levels of perseverance with regard to computers, despite their contexts which are often less than comfortable. The two questions refer to both perseverance in solving problems in a computer class (81% agree) and perseverance in dealing with problems relating to a computer program (72% agree).

4.3.3 Confidence

The third subsection, confidence will be discussed under the following sections: computer confidence, willingness to engage in computer tasks, Mathematics confidence, attitude to problem solving with computers and perceived ability with new technology.

4.3.3.1 Computer Confidence

Computer confidence is often referred to as computer self-efficacy. Computer self-confidence or computer self-efficacy expresses a belief in one's capability to perform a task. Self-confidence influences task effort, determination, the amount of interest that is expressed, the level of difficulty of the selected goal and the final result (Palaigeorgiou *et al.*, 2005: 332). Chang (2005: 714) defines computer confidence as a person's positive attitude as the result of knowledge experience in the use of computers. A person believes that he or she has sufficient familiarity with a computer, knowledge of a computer, and skills to handle a given task, and also has the ability to control the outcome of computer operations. Teachers' confidence in their technology skills and beliefs about the role of technology in enhancing student learning acts as a facilitator or hindrance to technology use (Bennison & Goos, 2010: 47). Teachers who have high levels of competencies in the TPCK dimensions (such as confidence in their technology skills) often have high levels of achievement. Since TPCK requires that students have confidence in combining different knowledge domains successfully it links to self-efficacy beliefs and consequently also student success (Erdogan & Sahin, 2010: 2711). Figure 4.15 demonstrates a typical lecture room at the University of Joensuu, Finland. The integration of pedagogy and technology is visible in this illustration.



Figure 4.15 Lecture Room at the University of Joensuu in Finland

An analysis of the PISA 2006 data reveals variables that influence Mathematics achievement; they are gender, quality of educational resources, home educational resources, index of economic, social and cultural status, ICT Internet/entertainment use, self-confidence in ICT, high level-tasks and teacher-student ratio (Demir *et al.*, 2010: 3103). Literature reveals that computer confidence and computer attitude are very much interrelated (Chang, 2005: 727; Levine & Donitsa-Schmidt, 1997: 139). A user's computer confidence and ability to

handle a task of certain complexity are more relevant in dealing with computer anxiety than the sentiment of liking computers (Chang, 2005: 727). Levine *et al.* (1997: 139) argue that the existence of mutually supportive relationships between confidence and attitude are particularly noteworthy considering that these effects are almost identical, and neither influences can be ruled out. In Figure 4.16 the teacher-students' perceived competency with computers is illustrated.



Figure 4.16 Teacher-students' Perceptions of their Computer Competency

ICT competence is an important condition for effective ICT use by teachers (Pelgrum, 2001: 177). Confidence in using computers is linked to perceived competence with computers. The teacher-students' perceptions of their own competency with using a computer was very high (Figure 4.4). Only 7.5% thought that their computer competency was bad or very bad, the other 92.5% considered their competency to be somewhere on a scale between average and excellent. Forty comma six percent considered themselves to be good or excellent at using a computer. A high level of competency signifies a high level of confidence. This contributes towards having a positive attitude towards computers. Four questions relate to computer confidence as can be seen in Table 4.12.

Table 4.12 Indicators of Computer Confidence

Question		Disagree	Neutral	Agree
6	I'm no good with computers	63%	18%	19%
15	I am sure I could work with computers	2%	6%	92%
26	I could get good grades in a computer class	3%	14%	83%
29	I have a lot of self-confidence when it comes to working with computers	8%	16%	76%

Questions 6 and 29 were two direct statements one positive and one negatively phrased which dealt with actual computer confidence. The other two, questions 15 and 26 are as-

assumptions that refer to the student-teachers' expected confidence in their computer ability. These ratings are quite high (92% and 83% agree) in comparison with those of the direct statements (63% negatively phrased and 76% positive). When comparing the perceptions of actual confidence versus the expected confidence, Figure 4.17 indicated higher levels of expected confidence than actual confidence.

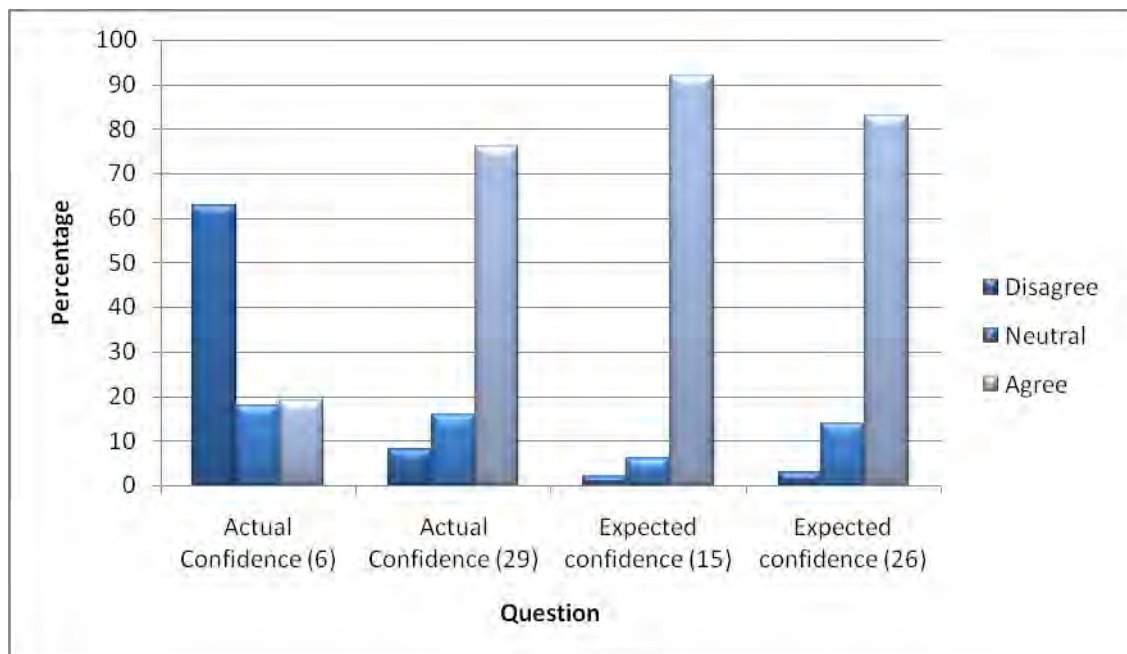


Figure 4.17 Actual Confidence Compared to Expected Confidence

Question six did not present a positive confidence in computers as convincingly as the other questions. This might be because all teacher-students in this population have not received computer training. For the students from the NWU which makes up the majority of the population, they are compelled to do a basic computer course which has a theoretical as well as a practical component. This forms part of their curriculum requirements. For many this is their first acquaintance with computers. According to Pelgrum (2001: 165), educational innovations do not succeed if teachers are not provided with the skills and knowledge needed to carry them out. For some, this lack of skills and knowledge could be the cause of lower confidence levels with regard to ICTs. The value of TPCK for the teacher to be able to integrate their skills and knowledge of technology successfully into their teaching processes cannot be underestimated.

Various reasons are suggested as to why teachers lack competence and/or confidence with regard to making ICT part of their pedagogical practice. According to Jones (as quoted by Pelgrum (2008: 96)), some of these reasons include the lack of time for training, lack of pedagogical training and lack of fit between training opportunities and teacher needs. When

examining the results from SITES 2006, these factors certainly do impact the use of ICT in South African schools. The availability of computer courses (introductory, technical and advanced) to South African educators is a problem, only a few schools indicated that such courses were available. With regard to technical courses, less than a quarter of the schools in South Africa reported the availability of these types of courses. For courses on pedagogical issues related to integrating ICT into teaching and learning, sizeable numbers of South African schools did not seem to have access to such courses (Pelgrum, 2008: 97). In general, SITES 2006 reports that teachers were more confident about using ICT in everyday situations than in teaching and learning situations. More specifically, teachers in South Africa reported the lowest levels of competence in both general and pedagogical ICT-use (Law & Chow, 2008: 192). Law and Chow (2008: 192) are of the opinion that a teacher's ICT competence will affect his or her adoption of ICT-use in teaching and learning.

Confidence in computer using abilities allows individuals to increase their knowledge and skills in applying computing technology to complete computer-related work. Higher perceptions of self-efficacy also lead individuals to produce more positive outcome expectations (Shih, 2006: 1021). Shih's study also revealed that IT students with good computer competence can expect to achieve better homework performance and within the job sector, employees with higher computer competence would have higher outcome expectations of using computer technology in computer-related work than individuals with lower computer competence (Shih, 2006: 1021). This implies positive outcomes for the teacher-students involved in this study since their confidence levels, both actual and expected, remained relatively high, meaning they have the opportunities to increase their knowledge and skills in using computer technology in their work environment. More specifically, these increased levels of confidence imply that student-teachers will more readily adopt ICT-use in their teaching and learning.

4.3.3.2 Willingness to Engage in Advanced Computer Tasks

This sub-topic links closely with having confidence in computers. It implies one step further than just confidence, and refers to a willingness to be involved in advanced computer tasks. An important strategy for ICT integration is the professional development of ICT teachers. These activities are intended to improve teachers' skills in ICT and to promote not only their confidence in using computers in their teaching, but also a positive attitude towards ICT (Galanouli *et al.*, 2004: 63). They argue that successful ICT professional development needs to be flexible and should reflect the level of competence of the teachers involved. Valcke *et al.* (2007: 805) suggest that ICT training has to be organised during school hours and that the school be used as the training location, especially so that the specific questions, needs

and problems of the school can be addressed. The professional development of teachers in the context of ICT integration is not only about taking part in in-service teacher training courses, but also about remaining informed about ICT and experimenting with it before making use of it in the classroom (Albirini, 2006: 385). Figure 4.18 illustrates a presentation at the University of Joensuu in Finland.



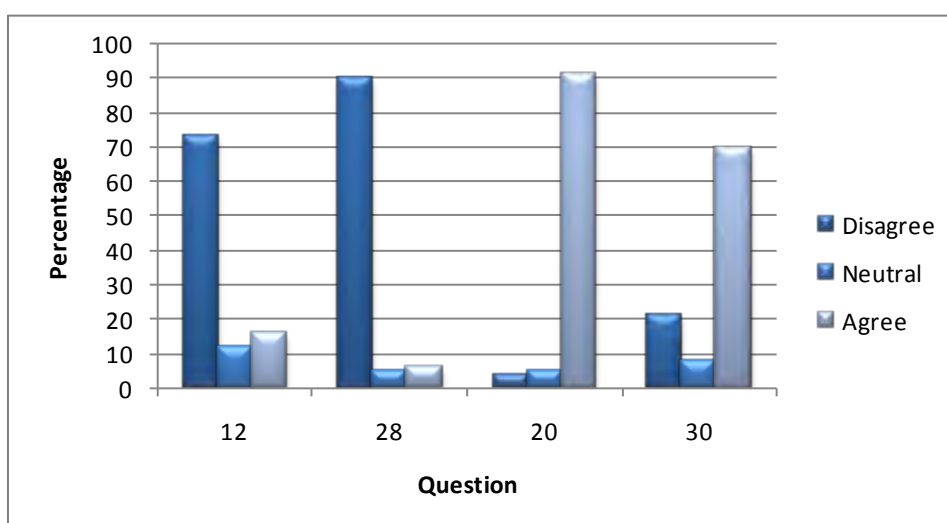
Figure 4.18 Presentation at the University of Joensuu, Finland

The importance of training teachers to integrate computers in their teaching is vital. If they have the ability to use computer technology as part of their instruction, it also enhances students' ability to use computers in a classroom setting (Mofokeng & Mji, 2010: 1614). Technology-related professional development participation is related to greater confidence with technology and creates more positive beliefs about the use of technology being of assistance for students' learning of Mathematics (Bennison & Goos, 2010: 52). It is essential to remember that technology should not be treated as a separate knowledge base that is unrelated to teaching tasks and contexts. It is not only about what technology can do for these teachers, but more important, what technology can do for them as teachers (Koehler *et al.*, 2007: 742). The information presented in Table 4.13 provides a good indication of how teacher-students feel about engaging in computer tasks.

Table 4.13 Indicators of Willingness to Engage in Computer Tasks

	Question	Disagree	Neutral	Agree
12	I don't think I would do advanced computer work	73%	12%	16%
20	I'm sure I could learn a computer language	4%	5%	91%
28	I do not think I could handle a computer course	90%	5%	6%
30	It wouldn't bother me at all to take computer courses	21%	8%	70%

Questions 12 and 28 were negatively phrased questions of which the responses indicated a strong willingness to do advanced computer work. *I'm sure I could learn a computer language* scored 91% on the Agree column, as did *It wouldn't bother me at all to take computer courses*, which earned 70% in the Agree column. Questions 20 and 30 were positively phrased and results showed that the majority of the teacher-students were willing to learn a computer language and were willing to take computer courses. The results of these four questions indicated more than just the basic use and acceptance of computers, they showed that the teacher-students were willing to explore ICTs beyond what was familiar to them and indicated a positive attitude towards ICTs. Figure 4.19 clearly indicates the high levels of agreeability of teacher-students to engage in tasks on the computer.

**Figure 4.19 Representation of Agreeability to Engage in Computer Tasks**

According to the SITES 2006 data, the results of the Mathematics teacher questionnaire indicates that teachers are more than willing to be involved in professional development activities that involve ICTs. Question 24 read as follows: Have you participated in any of the following professional development activities? If no, would you wish to attend? A summary of how the South African Mathematics teachers felt, and how they responded to this questionnaire is presented in Figure 4.20 (Pelgrum, 2008: 100).

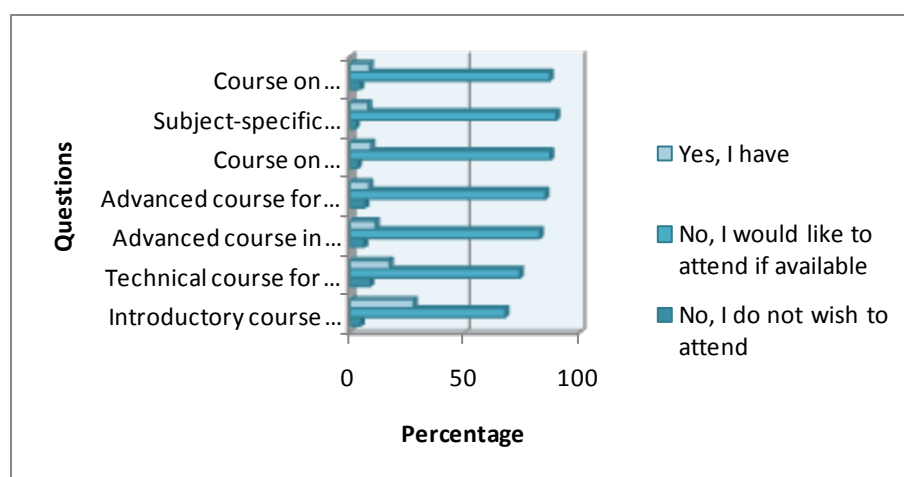


Figure 4.20 SITES 2006 Data Concerning Involvement in ICT training

This data confirms the findings of the present study which indicates that there is a willingness and desire for teachers to be involved in further training with regard to ICTs. To further support this idea, the findings of a study involving Maths and Science teachers in South Africa indicate that teachers expressed a wish to attend training on aspects of computing related to teaching Mathematics and Science (Mofokeng & Mji, 2010: 1610). Koehler *et al.* (2007: 743) believe that good teaching with technology requires the representation and formulation of concepts using technologies; pedagogical techniques that employ technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help address these issues; knowledge of students' prior knowledge; and an understanding of how technologies can be used to build on existing knowledge.

4.3.3.3 Mathematics Confidence

The effect that attitude has on Mathematics learning has been widely studied and most often reveals that confidence is the affective variable that most consistently relates to achievement in Mathematics. Although there is also much work done on the role of attitudes in computer education, the link between attitudes and the use of computers to learn Mathematics is a relatively new field of study (Cretchley & Harman, 2001: 17). It is important to keep those who are motivated to study Mathematics interested in the field and develop strategies to make the study more attractive to those who are not interested.

From the data it appeared that the confidence levels of our teacher-students were relatively high. As can be seen in Table 4.14, questions 33, 34 and 35 were phrased in a negative manner, but with high disagree rates, indicated that student-teachers believed that they have

a mathematical mind (86%) and that they do not take longer than the average person to understand Mathematics (85%) and feel that they are able to learn Mathematics (71%).

Table 4.14 Indicators of Mathematics Confidence

#	Question	Disagree	Neutral	Agree
31	I have less trouble learning Mathematics than other subjects	18%	14%	68%
32	Even when I battle with maths I know I can solve the problem	5%	9%	86%
33	I do not have a mathematical mind	86%	5%	8%
34	It takes me longer to understand maths than the average person	85%	7%	8%
35	I have never felt that I am able to learn maths	71%	9%	19%

The other two questions confirmed this notion of high confidence among student-teachers. 68% of the population believed that they had less trouble learning Mathematics than other subjects and 86% believed that although finding difficulty with Mathematics, they know that they can solve the problem.

Students' feelings of confidence need to be well regulated, because such feelings have an impact not only on their motivation to engage in tasks, but also the learning strategies that they bring to bear on the task (Boekaerts & Rozendaal, 2010: 379). The integration of computers into the learning of Mathematics is empowering and enlivening. Those with low computer confidence should be introduced gently to the use of technology in Mathematics learning and should be given some level of control over how much technology they must use for learning (Cretchley & Harman, 2001: 21).

4.3.3.4 Attitude to Problem-solving with Computers

Koehler *et al.* (2007: 741), who have done extensive research in teacher education and technology, report that the approaches followed by various teacher education programmes that have implemented instructional technology in an integrated way, involve providing teachers and teacher candidates with experiences with real educational problems to be solved by technology. In their own research work, they too involve in-service teachers in authentic problem-solving with technology to capture the essential qualities of teacher knowledge required for technology integration in pedagogy. The three questions in Table 4.15 give an indication of what the population in this study feel about solving problems with computers.

Table 4.15 Indicators of Attitude to Problem-solving with Computers

	Question	Disagree	Neutral	Agree
7	The challenge of solving problems with computers does not appeal to me	49%	25%	26%
9	Generally I would feel OK about trying a new problem on the computer	4%	9%	88%
13	Figuring out computer problems does not appeal to me	50%	27%	22%

The results of these three questions were not as clear cut as previous issues. The two questions: *The challenge of solving problems with computers does not appeal to me* and *Figuring out computer problems does not appeal to me* were predominantly rated as Disagree, but only with percentages of 49% and 50%. The other question relating to feeling positive about trying a new problem on the computer, had 88% of student-teachers agreeing with that statement.

According to the responses of the Mathematics teachers in SITES 2006 to the question: Has the use of ICT contributed to changes in the students' problem-solving skills in the target class? It is evident that learners' problem-solving skills to a large extent did increase. Figure 4.21 illustrates the influence that ICT had on learners' problem-solving skills according to SITES 2006 (Voogt, 2008: 232).

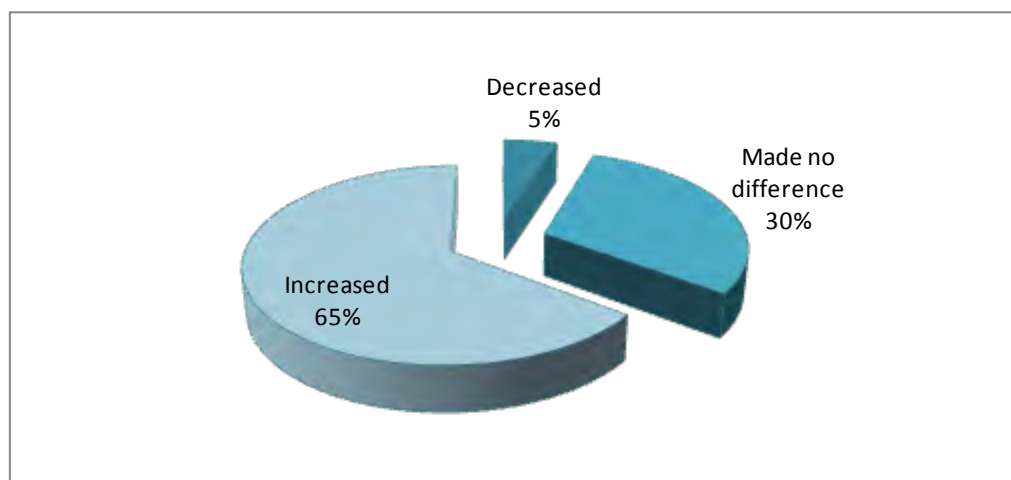


Figure 4.21 Contribution of ICT to Changes in Learners' Problem-solving Skills

Concerning student outcomes, Science and Mathematics teachers who used ICT on a weekly basis appear to be more convinced that students' ICT-skills, learning motivation, ability to learn at their own pace, communication skills, problem-solving skills and self-esteem increased (Voogt, 2008: 232).

4.3.3.5 Perceived Ability with New Technology

There was only one question that related to the topic of perceived ability with new technology. There was a 67% agreement that student-teachers believed they were good at using VCR's, DVD's, MP3's and mobile phones. The span of technology that was mentioned here was quite wide, which made the question difficult to accurately interpret. Where students might be good at using mobile phones, they might not know what VCR's are since they are fairly outdated, or might not be good at using DVD's etc. Their answer to the question would then be deceptive because they might be competent at using some of the items listed, but not all. However, a 67% agreement rate was still quite good, regardless of the confusion the question might have created. This means that the population in question mostly believed that they were good at using new technology. Table 4.16 indicates what teacher-students' believe they are able to do with new technology.

Table 4.16 Indicators of Perceived Ability with New Technology

#	Question	Disagree	Neutral	Agree
42	I am good at using VCR's, DVD's, MP3's and mobile phones	10%	7%	67%

This again is an indication of a positive attitude of this population towards computers, keeping in mind their contexts. According to Anderson and Plomp (2008: 42), reporting about SITES 2006, the number of mobile phone users per 1000 population in 2003 in Finland is 954 and in South Africa is 428. They present similar statistics concerning the number of Internet users per 1000 population in the same year; Finland is 629 and South Africa is a mere 78. It is phenomenal to think that the population of this study which is predominantly from the South African context are so positive about computers, technology and ICTs despite their limited access. Tanzania was not part of the SITES study, so no data could be reported for them.

Although schools might have Internet access (some very limited), it does not guarantee that learners have sufficient access. When reporting on the 2006 SITES study, Pelgrum (2008: 77) says that in South Africa, more schools had ratios greater than 40 students to one computer, despite the fact that the number of schools possessing any computers increased dramatically from 1998 to 2006. Although the infrastructure for communication in Tanzania is not always reliable, there are visible signs of the promise of technology to the community, as is illustrated in Figure 4.22.



Figure 4.22 Signs of the Promise of Technology in Tanzania

4.4 Willingness of Teacher-students to Use Computers

The second sub-question is: *To what extent are teacher-students willing to use computers?* This question will be discussed by identifying themes or clusters of ideas that relate to the concept of willingness.

In this study the dependent variable is attitude to computers and there are a number of independent variables, namely: the age of the students, gender, ownership of a computer, number of hours spent using a computer at home, access to a computer at school, number of hours spent using the computer at school, computer anxiety, computer liking and computer confidence. Since there are a number of variables to investigate, the variables will be reduced by grouping those that are moderately or highly correlated with one another into factors (Fraenkel & Wallen, 2003: 343). According to Fraenkel and Wallen (2003: 343), factor analysis is a technique that allows a researcher to determine if many variables can be described by a few factors. The technique involves a search for clusters of variables which are correlated with each other. These interrelated variables should reflect underlying themes or factors within the data (Leedy & Ormrod, 2010: 282). Factor analysis was done to determine to what extent teacher-students were willing to use computers.

Literature reveals to us a number of variables that have been identified in Loyd and Gressard's computer attitude scale. Smith *et al.* (2000: 63) identify three subscales of 10 items each: computer anxiety, computer liking and computer confidence. Each item is rated on a

five-point Likert-type scale. The ratings range from strongly disagree (1) to strongly agree (5). A high score on the anxiety subscale corresponds to higher anxiety, and high scores on the computer liking and computer confidence subscales corresponds to a more positive attitude towards learning about and working with computers (Smith *et al.*, 2000: 63)

Other research reveals that CAS can be divided into the following four variables: computer anxiety which assesses the fear of computers; computer confidence which assesses the confidence in the ability of dealing with computers; computer liking which assesses the enjoyment of dealing with computers and finally computer usefulness which assesses the perception of the proliferation of computers on future jobs (Moroz & Nash, 1997; Yushau *et al.*, 2005).

Data were analysed by Statistical Consultation Services of the North West University. A factor analysis was done which revealed nine factors from the 42 questions, which means that 56% of the variance is explained. By exploring these nine factors, rather than each question, the implication is that 56% of the information is maintained. To determine which questions belong together, a rotation is performed. With an oblique rotation, factors that share commonalities were grouped together.

Of the nine factors that the analysis identified, seven will be explored in more detail. The two that have been omitted do not indicate high levels of reliability. Variables that are not found to be related or only slightly related (i.e. when correlations of below 0.20 and above -0.20 are obtained) are dropped from further consideration, while those found to be more highly related (i.e. when correlations beyond +0.40 or -0.40 are obtained) often serve as the focus of additional research (Fraenkel & Wallen, 2003: 339). Table 4.17 shows the factor loadings. It represents which questions are clustered together and which questions link to which factor. The eighth and ninth factors have been omitted because of their low levels of reliability.

Table 4.17 Pattern Matrix

#	Question	Factor						
		1	2	3	4	5	6	7
25	If a problem is left unsolved in a computer class, I would continue to think about it afterwards	0.618						0.223
21	Once I start to work with a computer, I would find it hard to stop	0.361				0.261	-0.297	
17	When there is a problem with a computer program that I can't immediately solve, I would stick with it until I have the answer	0.350						
20	I'm sure I could learn a computer language	0.336						
27	I do not enjoy talking with others about computers	-0.453	0.298			0.222		
34	It takes me longer to understand maths than the average person		0.536					
24	Computers make me feel uneasy and confused		0.467			0.266		
33	I do not have a mathematical mind		0.445					-0.418
41	I find Mathematics confusing		0.427					-0.285
22	I think using a computer would be very hard for me		0.358	0.251		0.281		
28	I do not think I could handle a computer course	-0.261	0.321					
35	I have never felt that I am able to learn maths		0.284					
4	I feel aggressive and hostile towards computers			0.506				
1	Working with a computer would make me nervous			0.434				
14	I get a sinking feeling when I think of trying to use a computer			0.405		0.234		
30	It wouldn't bother me at all to take computer courses			-0.244				
23	I will do as little work with computers as possible			0.213				
37	I find Mathematics frightening		0.267	0.312				-0.335
7	The challenge of solving problems with computers does not appeal to me				-0.684			
13	Figuring out computer problems does not appeal to me				-0.654			
26	I could get good grades in a computer class	0.381				-0.288		
6	I'm no good with computers					0.530		
42	I am good at using VCR's, DVD's, MP3's and mobile phones					-0.429		
18	I'm not the type to do well with computers					0.370		
12	I don't think I would do advanced computer work				-0.244	0.268		
8	Computers make me feel uncomfortable					0.381	0.236	

#	Question	Factor						
		1	2	3	4	5	6	7
29	I have a lot of self-confidence when it comes to working with computers	0.205				-0.334	-0.267	
16	I would feel comfortable working with a computer						-0.593	
11	I think working with computers would be enjoyable and stimulating						-0.555	
10	I would feel at ease in a computer class				0.201		-0.466	
15	I am sure I could work with computers	0.338				-0.258	-0.400	
2	I would like working with computers						-0.399	
9	Generally I would feel OK about trying a new problem on the computer						-0.399	
32	Even when I battle with maths I know I can solve the problem							0.639
36	I enjoy trying to solve new Mathematics problems	0.228						0.578
31	I have less trouble learning Mathematics than other subjects							0.558
38	I find many Mathematics problems interesting and challenging							0.554
40	I have never been very excited about Mathematics							-0.313

Table 4.13 indicates the seven factors that proved to be statistically reliable. These factors appeared to indicate the following categories of variables:

- Factor 1 perseverance
- Factor 2 lack of computer or Mathematics confidence
- Factor 3 computer or Mathematics anxiety
- Factor 4 attitude to problem-solving with computers
- Factor 5 self-perceptions about technology
- Factor 6 computer confidence
- Factor 7 Mathematics attitude.

The factors included 2 to 8 items whose internal consistency coefficients using Cronbach's alpha reliability ranged between 0.555 and 0.850. Table 4.18 provides the reliability values for each dimension.

Table 4.18 Reliability for Various Attitude Factors

Factor	Cronbach's Alpha coefficient
Perseverance	0.788
Lack of Computer or Mathematics confidence	0.811
Computer or Mathematics anxiety	0.603
Attitude to problem-solving with computers	0.622
Self-perceptions about technology	0.668
Computer confidence	0.850
Mathematics Attitude	0.780
Dislike of Mathematics or computers	0.555
Fear of computers	0.564

The reliability of the two factors *dislike of Mathematics or computers* and *fear of computers* are not at an acceptable level since the alpha coefficient is below 0.60 (Pietersen & Maree, 2007a: 216). The factors that have been identified in this section can be divided into two categories, namely enablers and barriers to determine teacher-students' willingness to use ICT. Table 4.19 illustrates the two categories of factors that have been identified.

Table 4.19 Barriers and Enablers to Determine Teacher-students' Willingness to Use Computers

Barriers to deter willingness				Enablers to promote willingness			
Barrier factor	Question number	Question	Correlation	Enabling factor	Question number	Question	Correlation
Lack of computer or Mathematics confidence	41	I find Mathematics confusing	0.427	Perseverance	25	If a problem is left unsolved in a computer class, I would continue to think about it afterwards	0.618
	33	I do not have a mathematical mind	0.445		21	Once I start to work with a computer, I would find it hard to stop	0.361
	24	Computers make me feel uneasy and confused	0.467		17	When there is a problem with a computer program that I can't immediately solve, I would stick with it until I have the answer	0.350
	34	It takes me longer to understand maths than the average person	0.536		20	I'm sure I could learn a computer language	0.336
	27	I do not enjoy talking with others about computers	0.298	Computer confidence	16	I would feel comfortable working with a computer	-0.593
	22	I think using a computer would be very hard for me	0.358		11	I think working with computers would be enjoyable and stimulating	-0.555
	28	I do not think I could handle a computer course	0.321		10	I would feel at ease in a computer class	-0.466

Barriers to deter willingness				Enablers to promote willingness			
Barrier factor	Question number	Question	Correlation	Enabling factor	Question number	Question	Correlation
Attitude to problem-solving with computers	7	The challenge of solving problems with computers does not appeal to me	-0.684		15	I am sure I could work with computers	-0.400
	13	Figuring out computer problems does not appeal to me	-0.654		2	I would like working with computers	-0.399
Computer or Mathematics anxiety	14	I get a sinking feeling when I think of trying to use a computer	0.405		9	Generally I would feel OK about trying a new problem on the computer	-0.399
	1	Working with a computer would make me nervous	0.434		29	I have a lot of self-confidence when it comes to working with computers	-0.267
	4	I feel aggressive and hostile towards computers	0.506		8 *	Computers make me feel uncomfortable	
				Mathematics attitude	38	I find many Mathematics problems interesting and challenging	0.554
					31	I have less trouble learning Mathematics than other subjects	0.558
					36	I enjoy trying to solve new Mathematics problems	0.578
					32	Even when I battle with maths I know I can solve the problem	0.639
					40 *	I have never been very excited about Mathematics	
				Self-perceptions about technology	6	I'm no good with computers	0.530
					18	I'm not the type to do well with computers	0.370
					12	I don't think I would do advanced computer work	0.268
					42 *	I am good at using VCR's, DVD's, MP3's and mobile phones	
					26 *	I could get good grades in a computer class	

* Indicates questions that were reversed

The enablers include: perseverance, computer confidence, Mathematics attitude and self-perceptions about technology and the barriers include: lack of computer or Mathematics confidence, computer anxiety and attitude to problem-solving with computers. The category which was labelled as computer or Mathematics anxiety should be cautiously interpreted since the Cronbach's alpha is relatively low. The theoretical groupings that were done in § 4.3 are confirmed by the statistical findings from the factor analysis. The same themes reappear in the clusters of variables that have been identified through statistical analysis. Anxiety, lack of confidence and negative attitudes serve as a barriers to teacher-students' willingness to use computers while confidence and positive attitudes act as enablers. Along with the theme of confidence, attitude to problem-solving and self-perceptions about technology also serve as an indication of students' confidence levels. Computer liking is represented by the theme of perseverance.

When these themes were taken into consideration and the teacher-students' responses were analysed, it appeared that there were more enabling factors to promote their willingness to use computers than barriers. Teacher-students in this study therefore appeared to be willing to use computers.

4.5 Comparison of Attitudes in Tanzania, Finland and South Africa

To answer the third research question, *What is the comparison of these attitudes with those of students in a developing and a developed country i.e. Tanzania and Finland?*, descriptive statistics and effect sizes were used. The same subscales that were used to discuss the attitude of the group of respondents to computers, namely anxiety, liking and confidence will be used in this section. The enablers and barriers to the students' willingness to use computers, as was revealed by the factor analysis will also be compared and similarities and differences between the countries will be highlighted. Table 4.20 provides a detailed presentation of the categories that will be compared in order to answer the final research question.

Table 4.20 Categories of Comparison

Attitude	Sub-categories	Questions	South Africa			Tanzania			Finland		
			Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree
Anxiety	Positive indicators Computer anxiety	3 Computers do not scare me at all	5.7%	6.3%	87.9%	16.5%	16.5%	67%	15.3%	20.3%	64.4%
		5 I do not feel threatened when others talk about computers	9.2%	5.1%	85.7%	22%	6.4%	71.5%	16.9%	33.9%	66.1%
		10 I would feel at ease in a computer class	5.1%	11.1%	83.9%	9.5%	9.5%	81%	11.9%	45.8%	42.4%
	Negative indicators Computer anxiety	1 Working with a computer would make me nervous	85.5%	11.0%	3.5%	44.8%	11.4%	43.8%	45.8%	27.1%	8.5%
		8 Computers make me feel uncomfortable	92.4%	3.8%	3.8%	93.6%	0%	6.3%	55.9%	22.0%	6.8%
		22 I think using a computer would be very hard for me	94.6%	3.2%	2.2%	88.3%	2.7%	9%	54.2%	18.6%	5.1%
		24 Computers make me feel uneasy and confused	93.9%	3.8%	2.2%	90.9%	4.5%	4.5%	66.1%	23.7%	10.2%
	Mathematics anxiety	37 I find Mathematics frightening	92.4%	3.2%	4.5%	75.5%	11.8%	12.8%	54.4%	29.8%	15.8%
		41 I find Mathematics confusing	92.4%	3.8%	3.9%	81.1%	6.3%	12.6%	33.3%	36.8%	29.9%
	Affective factors	4 I feel aggressive and hostile towards computers	83.7%	9.9%	6.4%	60.4%	9.9%	29.7%	71.2%	25.4%	3.4%
		14 I get a sinking feeling when I think of trying to use a computer	89.9%	6.0%	4.1%	64.2%	13.8%	22%	82.1%	14.3%	3.6%
		16 I would feel comfortable working with a computer	1.3%	2.8%	95.9%	2.8%	0.9%	96.3%	12.5%	26.8%	60.7%
		18 I'm not the type to do well with computers	84.9%	10.3%	4.8%	67.3%	12.7%	20.0%	43.1%	32.8%	24.1%

Attitude	Sub-categories	Questions	South Africa			Tanzania			Finland		
			Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree
Liking	Access and willingness to use Technology	10 I would feel at ease in a computer class	5.1%	11.1%	83.9%	9.5%	9.5%	81%	11.9%	45.8%	42.4%
		9 Generally I would feel OK about trying a new problem on the computer	2.2%	5.4%	92.5%	0.9%	4.6%	94.5%	18.6%	32.2%	49.2%
		6 I'm no good with computers	58.5%	22.5%	18.9%	75.0%	6.5%	18.5%	65.5%	15.5%	18.9%
		5 I do not feel threatened when others talk about computers	9.2%	5.1%	85.7%	22.0%	6.4%	71.5%	16.9%	33.9%	66.1%
		3 Computers do not scare me at all	5.7%	6.3%	87.9%	16.5%	16.5%	67%	15.3%	20.3%	64.4%
	Computer liking	2 I would like working with computers	1.3%	1.6%	98.1%	1.8%	0%	98.2%	15.3%	37.3%	47.5%
		11 I think working with computers would be enjoyable and stimulating	1.9%	1.3%	96.8%	2.7%	0.9%	96.4%	100%	0%	0%
		19 I don't understand how some people can spend so much time working with computers and seem to enjoy it	74.1%	11.2%	14.7%	61.8%	13.6%	24.6%	43.6%	27.3%	29.1%
		21 Once I start to work with a computer, I would find it hard to stop	14.4%	13.5%	72.1%	15.5%	10.0%	74.6%	66.1%	25.4%	8.5%
		23 I will do as little work with computers as possible	73.4%	9.6%	17.0%	73.1%	4.6%	22.3%	48.3%	25.9%	15.5%
	Mathematics liking	40 I have never been very excited about Mathematics	85.7%	5.4%	8.9%	53.6%	11.8%	34.5%	32.8%	17.2%	50%
		39 I don't understand how some people seem to enjoy spending so much time on maths problems	76.0%	9.3%	14.7%	64.9%	18.9%	16.2%	38.6%	24.6%	36.9%

Attitude	Sub-categories	Questions	South Africa			Tanzania			Finland		
			Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree
		38 I find many Mathematics problems interesting and challenging	2.9%	2.5%	94.6%	2.7%	3.6%	93.7%	42.4%	18.6%	39.0%
	Perseverance during computer use	36 I enjoy trying to solve new Mathematics problems	3.5%	1.9%	94.6%	0.9%	1.8%	97.3%	43.1%	20.7%	36.2%
		25 If a problem is left unsolved in a computer class, I would continue to think about it afterwards	5.8%	5.4%	88.8%	1.9%	5.6%	92.5%	58.5%	24.9%	16.6%
		17 When there is a problem with a computer program that I can't immediately solve, I would stick with it until I have the answer	8.8%	14.5%	76.7%	17.1%	7.2%	75.7%	42.1%	24.6%	33.4%
Confidence	Computer confidence	6 I'm no good with computers	58.5%	22.5%	18.9%	75.0%	6.5%	18.5%	65.5%	15.5%	18.9%
		15 I am sure I could work with computers	0.6%	4.4%	95.0%	0.9%	0.9%	98.2%	12.5%	23.2%	64.3%
		26 I could get good grades in a computer class	1.9%	10.5%	87.5%	3.7%	0.9%	95.4%	10.2%	55.9%	33.9%
		29 I have a lot of self-confidence when it comes to working with computers	4.2%	14.7%	81.1%	4.5%	7.3%	88.2%	33.9%	42.4%	23.8%
	Willingness to engage in advanced computer tasks	12 I don't think I would do advanced computer work	77.3%	9.9%	12.8%	82.7%	5.5%	11.8%	24.1%	37.9%	38.0%
		20 I'm sure I could learn a computer language	2.2%	2.2%	95.5%	3.7%	2.8%	93.6%	13.6%	25.4%	61.0%
		28 I do not think I could handle a computer course	93.0%	2.6%	4.5%	89.2%	3.6%	7.2%	70.7%	19.0%	10.3%
		30 It wouldn't bother me at all to take computer courses	22.1%	1.6%	76.3%	20.2%	11.5%	68.3%	17.2%	37.9%	43.1%

Attitude	Sub-categories	Questions	South Africa			Tanzania			Finland		
			Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree
	Mathematics confidence	31 I have less trouble learning Mathematics than other subjects	12.5%	12.8%	74.6%	12.7%	10.9%	76.4%	37.3%	25.4%	18.6%
		32 Even when I battle with maths I know I can solve the problem I do not have a mathematical mind m	1.9%	4.5%	93.6%	0%	8.1%	91.9%	32.8%	31.0%	36.2%
		33 I do not have a mathematical mind	93.3%	3.5%	3.2%	90.9%	3.6%	5.4%	37.3%	18.6%	44.1%
		34 It takes me longer to understand maths than the average person	90.7%	4.2%	5.1%	88.1%	3.7%	8.3%	47.5%	30.5%	22.0%
		35 I have never felt that I am able to learn maths	76.2%	5.5%	18.3%	63.1%	9.9%	27.0%	62.1%	25.9%	12.1%
	Attitude to problem solving with computers	7 The challenge of solving problems with computers does not appeal to me	33.7%	24.0%	22.1%	44.3%	19.8%	35.8%	28.8%	42.4%	28.8%
		9 Generally I would feel OK about trying a new problem on the computer	2.2%	5.4%	92.5%	0.9%	4.6%	94.5%	18.6%	32.2%	49.2%
		13 Figuring out computer problems does not appeal to me	58.5%	24.9%	16.6%	36.7%	35.8%	27.6%	34.5%	19.0%	46.5%
	Perceived ability with new technology	42 I am good at using VCR's, DVD's, MP3's and mobile phones	11.7%	25.1%	63.2%	5.4%	13.5%	81.0%	6.9%	36.2%	56.9%
Willingness to use computers Enablers	Perseverance	25 If a problem is left unsolved in a computer class, I would continue to think about it afterwards	5.8%	5.4%	88.8%	1.9%	5.6%	92.5%	58.5%	24.9%	16.6%
		21 Once I start to work with a computer, I would find it hard to stop	14.4%	13.5%	72.1%	15.5%	10.0%	74.6%	66.1%	25.4%	8.5%

Attitude	Sub-categories	Questions	South Africa			Tanzania			Finland		
			Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree
		17 When there is a problem with a computer program that I can't immediately solve, I would stick with it until I have the answer	8.8%	14.5%	76.7%	17.1%	7.2%	65.7%	42.1%	24.6%	33.4%
		20 I'm sure I could learn a computer language	2.2%	2.2%	95.5%	3.7%	2.8%	93.6%	13.6%	25.4%	61.0%
	Computer confidence	16 I would feel comfortable working with a computer	1.3%	2.8%	95.9%	2.8%	0.9%	96.3%	12.5%	26.8%	60.7%
		11 I think working with computers would be enjoyable and stimulating	1.9%	1.3%	96.8%	2.7%	0.9%	96.4%	100%	0%	0%
		10 I would feel at ease in a computer class	5.1%	11.1%	83.9%	9.6%	9.5%	81%	11.9%	45.8%	42.4%
		15 I am sure I could work with computers	0.6%	4.4%	95.0%	0.9%	0.9%	98.2%	12.5%	23.2%	64.3%
		2 I would like working with computers	1.3%	1.6%	97.1%	1.8%	0%	98.2%	15.3%	37.3%	47.5%
		9 Generally I would feel OK about trying a new problem on the computer	2.2%	5.4%	92.5%	0.9%	4.6%	94.5%	18.6%	32.2%	49.2%
		29 I have a lot of self-confidence when it comes to working with computers	4.2%	14.7%	81.1%	4.5%	7.3%	88.2%	33.9%	42.4%	23.8%
		8* Computers make me feel uncomfortable	92.4%	3.8%	3.8%	93.6%	0%	6.3%	71.2%	22.0%	6.8%
	Mathematics attitude	38 I find many Mathematics problems interesting and challenging	2.9%	2.5%	94.6%	2.7%	3.6%	93.7%	42.4%	18.6%	39.0%
		31 I have less trouble learning Mathematics than other subjects	8.7%	12.8%	74.6%	12.7%	10.9%	76.4%	55.9%	25.4%	18.6%
		36 I enjoy trying to solve new Mathematics problems	3.5%	1.9%	94.6%	0.9%	1.8%	97.3%	43.1%	20.7%	36.2%

Attitude	Sub-categories	Questions	South Africa			Tanzania			Finland		
			Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree
		32 Even when I battle with maths I know I can solve the problem	1.9%	4.5%	93.6%	0%	8.1%	91.9%	32.7%	31.0%	36.2%
		40* I have never been very excited about Mathematics	85.7%	5.4%	8.9%	53.6%	11.8%	34.5%	32.8%	17.2%	50.0%
	Self-perceptions about technology	6 I'm no good with computers	58.5%	22.5%	18.9%	75.0%	6.5%	18.5%	65.5%	15.5%	18.9%
		18 I'm not the type to do well with computers	84.9%	10.3%	4.8%	67.3%	12.7%	20.0%	43.1%	32.8%	24.1%
		12 I don't think I would do advanced computer work	77.3%	9.9%	12.8%	82.7%	5.5%	11.8%	24.1%	37.9%	38.0%
		42 I am good at using VCR's, DVD's, MP3's and mobile phones	11.7%	25.1%	63.2%	5.4%	13.5%	81%	6.9%	36.2%	56.9%
		26* I could get good grades in a computer class	1.9%	10.5%	87.5%	3.7%	0.9%	95.4%	10.2%	55.9%	33.9%
Barriers	Lack of computer or Mathematics confidence	41 I find Mathematics confusing	92.4%	3.8%	3.9%	81.1%	6.3%	12.6%	33.3%	36.8%	29.9%
		33 I do not have a mathematical mind	93.3%	3.5%	3.2%	90.9%	3.6%	5.4%	37.3%	18.6%	44.1%
		24 Computers make me feel uneasy and confused	93.9%	3.8%	2.2%	90.9%	4.5%	4.5%	66.1%	23.7%	10.2%
		34 It takes me longer to understand maths than the average person	90.7%	4.2%	5.0%	88.1%	3.7%	8.3%	47.5%	30.5%	22.0%
		27 I do not enjoy talking with others about computers	89.5%	5.1%	4.5%	92.8%	3.6%	3.6%	33.3%	31.6%	35.1%
		22 I think using a computer would be very hard for me	94.6%	3.2%	2.2%	88.3%	2.7%	9%	54.2%	18.6%	5.1%
		28 I do not think I could handle a computer course	93.0%	2.6%	4.5%	89.2%	3.6%	7.2%	70.7%	19.0%	10.3%

Attitude	Sub-categories	Questions	South Africa			Tanzania			Finland		
			Disagree	Neutral	Agree	Disagree	Neutral	Agree	Disagree	Neutral	Agree
	Attitude to problem solving with computers	7 The challenge of solving problems with computers does not appeal to me	53.8%	24.0%	22.1%	44.3%	19.8%	35.8%	28.8%	42.2%	28.8%
		13 Figuring out computer problems does not appeal to me	58.5%	24.9%	16.6%	36.7%	35.8%	37.6%	34.5%	19.0%	46.5%
	Computer or Mathematics anxiety	14 I get a sinking feeling when I think of trying to use a computer	89.9%	6.0%	4.1%	64.2%	13.8%	22%	82.1%	14.3%	3.6%
		1 Working with a computer would make me nervous	85.5%	11.0%	3.5%	44.8%	11.4%	43.8%	45.8%	27.1%	8.5%
		4 I feel aggressive and hostile towards computers	83.7%	9.9%	6.4%	60.4%	9.9%	29.7%	71.2%	25.4%	3.4%

When comparing the three countries' responses in the categories used to discuss the first research question, namely anxiety, liking and confidence, there were some notable similarities and differences. Firstly when considering anxiety, it appeared from the responses that the South African respondents were the least anxious about computers and Mathematics. This might be due to the fact that all teacher-students enrolled for the ACE course at the NWU have a certain degree of exposure to computers, regardless of whether they own a computer or not, due to the compulsory computer literacy module in their course. The questions *Computers do not scare me at all* and *I do not feel threatened when others talk about computers* have an over 80% agree rate for the South Africans where the other two countries are in the region of 60%. The respondents from Finland were more neutral about feeling at ease in a computer class than the others. Concerning the negative indicators of computer anxiety, the two African countries both strongly disagreed with those questions, where the Finnish respondents did not strongly disagree to the same extent. The responses of the South Africans in the category of Mathematics anxiety again very strongly indicated their lack of anxiety, the Tanzanians also convincingly indicated low levels of anxiety, but the Finnish respondents were more divided in their opinions; some agreed to find Mathematics confusing (29.9%), some were neutral (36.8%) and some did not find it confusing (33.3%). The question *I get a sinking feeling when I think of trying to use a computer* may have been misunderstood by the Tanzanian students, where the other two groups mainly disagreed with this question, their response was not that convincing. It is possible that the language in which the question was phrased may have confused the respondents. The respondents from Finland felt less comfortable working with a computer than the other two groups. In general it appeared that the teacher-students from Finland were more anxious about computers than the other groups, and that the South African teacher-students show the lowest levels of anxiety of the three groups.

The second category is liking (computers and Mathematics). The Finnish students indicated that they were less willing to use technology and liked computers less than the two African countries. The question: *I think working with computers would be enjoyable and stimulating* had 100% disagree response rate in Finland compared to 96.8% agree in South Africa and 96.4% agree in Tanzania. The responses to the question: *Once I start to work with a computer, I would find it hard to stop* also indicated that the Finnish group liked computers less than the two African groups. A similar tendency occurred with the category of Mathematics liking. Indicators that referred to Mathematics liking were answered in a manner that indicated that the students in Finland liked Mathematics less than students in South Africa and Tanzania. A typical example of this tendency was the responses to the question: *I enjoy trying to solve new Mathematics problem*, where the Finnish students' agree rate was 38.2%,

Tanzania 97.3% and South Africa 94.6%. The last component of liking was perseverance during computer use. The two African countries again indicated higher levels of perseverance than the Finnish students. In conclusion, the students from Finland liked computers and Mathematics less than those in South Africa and Tanzania.

The confidence levels of the three groups followed a similar pattern. The computer confidence of the students in Finland was lower than that of the South Africans and Tanzanians. In the question: *I am sure I could work with computers* the Tanzanian students have the highest agree rate at 98.2%, the South Africans were second at 95.0% and the Finnish had only a 64.3% agree rate. *I could get good grades in a computer class* had similar responses, the African countries had a majority agree response, and the Finnish students were more neutral in their responses (55.9%). The self-confidence levels with regard to working with computers also clearly indicated that the Tanzanians showed the highest level of self-confidence (88.2%), followed by the South Africans (81.1%) and lastly the Finnish students (23.3%). The Finnish students were not confident about doing advanced computer work and learning a computer language, where the other two groups were, but they did indicate confidence in pursuing a computer course. The South Africans indicated most convincingly that they would be able to deal with a computer course. Generally, it appeared that the Tanzanians showed the most computer confidence, followed closely by the South Africans.

As with computer confidence, Mathematics confidence levels were highest in South Africa and Tanzania. All questions that indicated Mathematics confidence were answered such that the Finnish students showed the poorest confidence in Mathematics and the South Africans indicated the highest levels of confidence in Mathematics, with Tanzania following closely. Another indicator of confidence was attitude to problem solving with computers. Although the responses to the indicators in this category are slightly divided, the general impression was that the African countries again appear to be more positive about problem solving with computers. The final category in the confidence scale was perceived ability with new technology. The students in Tanzania were most confident (81.0%), followed by the South African students (63.2%), and surprisingly 56.9% of the students in Finland believed that they were good at using new technology. As with anxiety and liking, the same tendency occurred. The Finnish students were the least confident on all levels, followed by the Tanzanian students and the South African students, who were very similar in their responses.

When considering the second research question, the enablers and barriers to students willingness to use computers was discussed, and was investigated in each country separately. The first enabler was perseverance. The African countries showed the most perseverance

with computers. Computer confidence was discussed next, and as discussed above, the students in Tanzania were most confident about computers, followed by the students in South Africa and then those in Finland. The factor indicating Mathematics attitude revealed similar results as discussed above. The question *I have never been very excited about Mathematics* had a surprising response from the students in Tanzania. 53.6% disagreed, 11.8% were neutral and 34.5% agreed. In all the other questions relating to Mathematics attitude, the African countries were most positive and Finland was the least positive. In the factor relating to self-perceptions about technology, the responses of the three countries were quite similar. The Finnish students were inclined to indicate that their self-perceptions about technology were slightly lower than that of the other two countries, but responses in this category were less divided than other categories already discussed. According to these results, there are many factors that will enable the students in the developing countries to engage with technology more frequently, and their willingness to engage appears to be very good. Perhaps the reason why the students in Finland indicated lower levels of willingness to use technology was because their access to technology is so much greater than in the developing countries. They might be so used to using technology that their attitude to it and confidence about it has been affected in a negative manner.

The barriers to teacher-students' willingness to use technology were lack of confidence, anxiety and attitude to problem solving. The developing countries indicated more positive attitudes to both computers and Mathematics than the developed country. The three questions relating to the factor of attitude to problem solving do not provide a clear difference or similarity between the countries. Finally, concerning the barrier relating to anxiety, the teacher-students in South Africa appear to be the least anxious, followed by the Finnish students and then the Tanzanian students.

4.6 Practical Significant Differences between the Three Groups

To indicate whether findings are practically significant, an effect size was calculated. When looking at mean differences, the effect size is denoted by d . The guidelines for interpretation are listed in Table 4.21.

Table 4.21 Guidelines used for Data Interpretation

<i>d</i>	Meaning
$d \leq 0.2$	Small effect
$0.2 < d < 0.8$	Medium effect
$d \geq 0.8$	Large effect

(Pietersen & Maree, 2007d: 211)

Table 4.22 indicates the mean scores and the effect size for gender for the three different groups in relation to the nine identified factors.

Table 4.22 Effect of Gender on the Factors

Factors	South Africa			Tanzania			Finland		
	Male mean	Female mean	<i>d</i>	Male mean	Female mean	<i>d</i>	Male mean	Female mean	<i>d</i>
Factor 1: Perseverance	4.0132	4.1219	0.184	4.0578	3.9423	0.191	3.2875	2.6325	1.087
Factor 2: Lack of confidence	1.6147	1.6020	0.026	1.7051	1.6044	0.152	2.3667	2.7302	0.560
Factor 3: Anxiety	1.8260	1.8761	0.083	2.3483	2.6769	0.418	2.2192	2.4111	0.325
Factor 4: Attitude to problem solving with computers	2.4793	2.4626	0.018	2.8144	3.0769	0.283	2.7500	3.2821	0.604
Factor 5: Self-perceptions about technology	2.0713	2.0975	0.042	1.9316	2.0346	0.157	2.3075	2.8846	0.763
Factor 6: Computer confidence	4.3723	4.3795	0.017	4.4942	4.4423	0.102	3.6807	3.2889	0.514
Factor 7: Mathematics attitude	4.2667	4.1749	0.153	4.1327	4.0769	0.106	3.0250	2.6590	0.377
Factor 8: Dislike of Mathematics or computers	2.2235	2.0408	0.193	2.3622	2.5000	0.136	2.6250	3.0385	0.402
Factor 9: Fear of computers	4.2189	4.2347	0.019	3.8214	3.6154	0.196	4.2000	3.4103	0.882

Gender has a medium effect which tends towards a practically significant difference on the lack of confidence ($d = 0.560$), attitude to problem-solving with computers ($d = 0.604$), self-perceptions about technology ($d = 0.763$), computer confidence ($d = 0.514$) for Finland. There is a large effect on perseverance ($d = 1.087$) and fear of computers ($d = 0.882$) for the students in Finland. The effect sizes for the other two groups were not significant.

Table 4.23 indicates the mean scores and the effect size for having a computer at home for the three different groups in relation to the nine identified factors.

Table 4.23 Effect of Having a Computer at Home on the Factors

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>
Factor 1: Perseverance	4.1223	4.0148	0.183	4.0725	3.9798	0.159	2.8545	-	-
Factor 2: Lack of confidence	1.5610	1.6452	0.170	1.7378	1.6104	0.191	2.6069	-	-
Factor 3: Anxiety	1.8202	1.8741	0.089	2.3939	2.3919	0.003	2.3460	-	-
Factor 4: Attitude to problem solving with computers	2.5474	2.4246	0.125	2.9351	2.6875	0.269	3.1017	-	-
Factor 5: Self-perceptions about technology	1.9075	2.2106	0.490	1.9195	2.0288	0.159	2.6890	-	-
Factor 6: Computer confidence	4.4394	4.3271	0.257	4.4880	4.4729	0.30	3.4217	-	-
Factor 7: Mathematics attitude	4.2704	4.1878	0.151	4.1234	4.1061	0.30	2.7831	-	-
Factor 8: Dislike of Mathematics or computers	2.1095	2.1583	0.053	2.3571	2.3485	0.009	2.8983	-	-
Factor 9: Fear of computers	4.4234	4.0754	0.376	3.8442	3.6515	0.184	3.6780	-	-

For the group in Finland, all students responded yes to the question *Do you have a computer at home?* Since there is no second response to do a comparison, the effect size cannot be calculated. There is no significant difference for the other two groups. Table 4.24 indicates the mean scores and the effect size for owning a mobile phone for the three different groups in relation to the nine identified factors.

Table 4.24 Effect of Owning a Mobile Phone on the Factors

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>
Factor 1: Perseverance	4.0704	4.0132	0.098	4.0602	3.3750	1.217	2.8649	2.2500	0.928
Factor 2: Lack of confidence	1.5775	1.7945	0.393	1.6596	2.0714	0.582	2.5928	3.4286	1.406
Factor 3: Anxiety	1.7943	2.1921	0.642	2.3593	2.9000	0.425	2.3463	2.3333	0.025
Factor 4: Attitude to problem solving with computers	2.4366	2.6622	0.241	2.8645	1.5000	1.504	3.0948	3.5000	0.463
Factor 5: Self-	2.0376	2.3390	0.480	1.9185	2.9000	1.543	2.6871	2.8000	0.159

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>
perceptions about technology									
Factor 6: Computer confidence	4.3795	4.3802	0.001	4.4934	4.3750	0.238	3.4204	3.5000	0.120
Factor 7: Mathematics attitude	4.2560	4.0053	0.419	4.1370	3.5000	1.254	2.8034	1.6000	1.308
Factor 8: Dislike of Mathematics or computers	2.0851	2.4605	0.423	2.3519	3.0000	0.659	2.8793	4.0000	1.195
Factor 9: Fear of computers	4.2699	3.9595	0.290	3.8380	2.5000	0.946	3.6810	3.5000	0.200

Ownership of a mobile phone in Tanzania have large practically significant differences on students' perseverance ($d = 1.217$), their attitude to problem solving with computers ($d = 1.504$), their self-perceptions about technology ($d = 1.543$), their Mathematics attitude ($d = 1.254$) and their fear of computers ($d = 0.946$). It has a medium effect, which tends towards a practically significant difference, on their dislike of Mathematics or computers ($d = 0.659$). For the group in South Africa mobile phone ownership only has a medium effect on anxiety ($d = 0.642$), and further no significant effect on any other factors. For the group of Finnish students, mobile phone ownership has a large practically significant difference on perseverance ($d = 0.928$), lack of confidence ($d = 1.406$), Mathematics attitude ($d = 1.308$), and dislike of Mathematics and computers ($d = 1.195$).

Table 4.25 indicates the mean scores and the effect size for having access to a computer at university for the three different groups in relation to the nine identified factors.

Table 4.25 Effect of Having Access to a Computer at University on the Factors

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>
Factor 1: Perseverance	4.0341	4.0655	0.048	4.0801	3.6250	0.655	2.8538	2.2500	0.911
Factor 2: Lack of confidence	1.6688	1.5971	0.147	1.6844	1.8214	0.206	2.6132	3.4286	1.408
Factor 3: Anxiety	1.9261	1.8465	0.119	2.3575	2.6417	0.334	2.3611	2.3333	0.053
Factor 4: Attitude to problem solving with computers	2.3977	2.5115	0.101	2.8812	2.4375	0.423	3.1140	3.5000	0.443

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>
Factor 5: Self-perceptions about technology	1.8909	2.1223	0.379	1.9059	2.4438	0.841	2.7061	2.8000	0.133
Factor 6: Computer confidence	4.4501	4.3650	0.197	4.5128	4.1563	0.653	3.4014	3.5000	0.151
Factor 7: Mathematics attitude	4.1591	4.2420	0.138	4.1314	4.0750	0.083	2.7895	1.6000	1.291
Factor 8: Dislike of Mathematics or computers	2.1250	2.1527	0.031	2.4020	2.1875	0.189	2.9123	4.0000	1.193
Factor 9: Fear of computers	4.2500	4.2222	0.033	3.8333	3.3750	0.436	3.6579	3.5000	0.176

Having a computer at university has no significant effect on the factors identified for the South African students. It has a medium effect on the Tanzanians' perseverance and computer confidence and a large effect on their self-perceptions about technology. For the group in Finland, access to a computer at university have practically significant differences in their perseverance ($d = 0.911$), lack of confidence ($d = 1.408$), Mathematics attitude ($d = 1.291$), and their dislike of Mathematics or computers ($d = 1.193$).

Table 4.26 indicates the mean scores and the effect size for being willing to do Mathematics on a computer for the three different groups in relation to the nine identified factors.

Table 4.26 Effect of being Willing to do Mathematics on a Computer on the Factors

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>
Factor 1: Perseverance	4.0654	3.6250	0.761	4.0594	3.5000	0.993	3.1006	2.5714	0.839
Factor 2: Lack of confidence	1.6031	2.2143	1.294	1.6914	1.7619	0.108	2.3095	2.8844	1.066
Factor 3: Anxiety	1.8450	2.4167	1.007	2.3960	2.0556	0.435	2.2621	2.3952	0.234
Factor 4: Attitude to problem solving with computers	2.4794	1.7500	0.778	2.8598	2.3333	0.570	2.8276	3.3929	0.603
Factor 5: Self-perceptions about technology	2.0805	2.3000	0.361	1.9259	2.5833	1.017	2.5069	2.8643	0.444
Factor 6: Computer confidence	4.3820	3.6250	1.757	4.4901	4.4167	0.148	3.6234	3.1811	0.668

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>
Factor 7: Mathematics attitude	4.2280	3.9000	0.464	4.1296	4.0000	0.216	3.0138	2.5071	0.524
Factor 8: Dislike of Mathematics or computers	2.1392	1.7500	0.437	2.3843	2.1667	0.219	2.6379	3.1786	0.551
Factor 9: Fear of computers	4.2397	2.5000	2.129	3.8287	2.6667	0.723	3.7069	3.6786	0.028

Being willing to do Mathematics on a computer have large practically significant differences on the South Africans' lack of confidence ($d = 1.294$), anxiety ($d = 1.007$), computer confidence (1.757) and fear of computers (2.129). There was a medium effect on their perseverance ($d = 0.761$) and their attitude to problem-solving with computers ($d = 0.778$). For the Tanzanian students, there is a practically significant difference in their self-perceptions about technology ($d = 1.017$) and medium effects, which tend towards practically significant differences, on their attitude to problem-solving with computers ($d = 0.570$) and fear of computers ($d = 0.723$). The Finnish students' willingness to do Mathematics on a computer show practically significant differences in their perseverance ($d = 0.839$) and lack of confidence ($d = 1.066$), as well as medium effects, which tend towards practically significant differences, on their attitude to problem solving with computers ($d = 0.603$), computer confidence ($d = 0.668$), Mathematics attitude ($d = 0.524$) and dislike of Mathematics or computers ($d = 0.551$).

Table 4.27 indicates the mean scores and the effect size for being willing to do Mathematics on a mobile phone for the three different groups in relation to the nine identified factors.

Table 4.27 Effect of being Willing to do Mathematics on a Mobile Phone on the Factors

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>	Yes mean	No mean	<i>d</i>
Factor 1: Perseverance	4.0825	3.8704	0.305	4.0459	4.0238	0.036	3.3088	2.6565	1.051
Factor 2: Lack of confidence	1.5867	1.8042	0.390	1.6750	1.7902	0.156	2.2675	2.7259	0.811
Factor 3: Anxiety	1.8317	1.9951	0.288	2.4015	2.3667	0.044	2.1647	2.3992	0.434
Factor 4: Attitude to problem solving with computers	2.4706	2.5000	0.031	2.8864	2.6667	0.214	2.6176	3.3049	0.741

Factors	South Africa			Tanzania			Finland		
	Yes mean	No mean	d	Yes mean	No mean	d	Yes mean	No mean	d
Factor 5: Self-perceptions about technology	2.0574	2.3185	0.395	1.9860	1.7714	0.323	2.2824	2.8561	0.686
Factor 6: Computer confidence	4.3959	4.1944	0.439	4.4613	4.5774	0.230	3.8312	3.2413	0.929
Factor 7: Mathematics attitude	4.2433	4.0704	0.318	4.0966	4.2381	0.278	2.8882	2.7341	0.156
Factor 8: Dislike of Mathematics or computers	2.1534	1.9630	0.213	2.3258	2.5714	0.244	2.5000	3.0732	0.598
Factor 9: Fear of computers	4.2318	4.2407	0.011	3.8539	3.5238	0.266	4.0882	3.5244	0.599

Only the students in Finland indicate an effect of being willing to do Mathematics on a mobile phone. There are practically significant differences in their perseverance ($d = 1.051$), lack of confidence ($d = 0.811$) and computer confidence ($d = 0.929$). There are medium effects, which tend towards practically significant differences, in their attitude to problem solving with computers ($d = 0.741$) and their computer confidence ($d = 0.929$).

4.7 Practical Significant Differences between the Three Groups with regard to the Identified Factors

To determine if there are practical significant differences between the three groups of teacher-students, namely in South Africa, Tanzania and Finland, an analysis of variance was used (ANOVA). Table 4.28 represents the results of the ANOVA.

Table 4.28 Practical Significant Differences as Determined by an ANOVA

Factor	Satisfaction	Sum of Squares	df	Mean square	F	Significance p
Factor 1: Perseverance	Between Groups	75.136	2	37.568	109.568	0.000
	Within Groups	166.293	485	0.343	-	-
	Total	241.429	487	-	-	-
Factor 2: Lack of confidence	Between Groups	50.191	2	25.095	88.217	0.000
	Within Groups	137.969	485	0.284	-	-
	Total	188.160	487	-	-	-
Factor 3: Anxiety	Between Groups	30.482	2	15.241	40.019	0.000
	Within Groups	184.709	485	0.381	-	-
	Total	215.191	487	-	-	-
Factor 4: Attitude to problem solving with computers	Between Groups	25.862	2	12.931	15.139	0.000
	Within Groups	412.561	483	0.854	-	-
	Total	438.422	485	-	-	-

Factor	Satisfaction	Sum of Squares	df	Mean square	F	Significance p
Factor 5: Self-perceptions about technology	Between Groups	23.005	2	11.502	29.118	0.000
	Within Groups	191.592	485	0.395	-	-
	Total	214.597	487	-	-	-
Factor 6: Computer confidence	Between Groups	51.253	2	25.626	111.467	0.000
	Within Groups	111.501	485	0.230	-	-
	Total	162.754	487	-	-	-
Factor 7: Mathematics attitude	Between Groups	104.972	2	52.486	147.881	0.000
	Within Groups	172.136	485	0.355	-	-
	Total	277.109	487	-	-	-
Factor 8: Dislike of Mathematics or computers	Between Groups	30.145	2	15.072	17.882	0.000
	Within Groups	408.797	485	0.843	-	-
	Total	438.942	487	-	-	-
Factor 9: Fear of computers	Between Groups	25.287	2	12.644	16.031	0.000
	Within Groups	381.739	484	0.789	-	-
	Total	407.027	486	-	-	-

The *F*-values have corresponding *p*-values of 0.000 and since this value is less than 0.05, it means that there are statistically significant differences among the means. This test does not indicate between which groups there are significant differences. In order to get that information, a post hoc test was done. The one that was used in this study was the Tukey HSD (honestly significant difference) test. Table 4.29 gives the results of this test.

Table 4.29 Tukey Honestly Significant Difference Test

Factor	Group	N	Subset for alpha = 0.05	
			1	2
Factor 1: Perseverance	2	59	2.8545	
	1	111		4.0443
	3	318		4.0626
Factor 2: Lack of confidence	3	318	1.6069	
	1	111	1.6933	
	2	59		2.6069
Factor 3: Anxiety	3	318	1.8486	
	2	59		2.3460
	1	111		2.3868
Factor 4: Attitude to problem solving with computers	3	318	2.4748	
	1	59		2.8455
	2	111		3.1017
Factor 5: Self-perceptions about technology	1	111	1.9437	
	3	318	2.0819	
	2	59		2.6890
Factor 6: Computer confidence	2	59	3.4217	
	3	318		4.3772
	1	111		4.4881
Factor 7: Mathematics attitude	2	59	2.7831	
	1	111		4.1261
	3	318		4.2259
Factor 8: Dislike of Mathematics or computers	3	318	2.1368	
	1	111	2.3784	
	2	59		2.8983
Factor 9: Fear of computers	2	59	3.6780	
	1	111	3.7973	
	3	317		4.2287

From Table 4.29 it follows that with regard to perseverance, group one and three (Tanzania and South Africa) are not significantly different since both are in subset two, but they are significantly different to group two (Finland). When considering lack of confidence, the same results occur. South Africa and Tanzania are not significantly different from each other but they are different to Finland. This statistically confirms the findings in the descriptive statistics (Section 4.4), where the South African and Tanzanian teacher-students were found to be more confident in computers and Mathematics than the students in Finland.

The subscale of anxiety and attitude to problem solving with computers indicate that the Tanzanian and the Finnish were not significantly different from each other, but were significantly different to the South Africans. Once again these findings confirm the descriptive statistics in § 4.4. The South Africans were found to be the least anxious of the three groups. Where previously there was no clear difference between the groups regarding attitude to problem solving with computers, this analysis reveals that the South Africans again proved to be significantly different to the other two groups.

The following four factors reveal the same differences, namely self-perceptions about technology, computer confidence, Mathematics attitude and dislike of Mathematics or computers. The analysis proves that there is no significant difference between the two African countries, but they were significantly different to the Finnish students. These results again confirm the findings in § 4.4. The African student-teachers were more confident, had a more positive attitude towards Mathematics, had more positive self-perceptions about technology and liked computers and Mathematics more than the students in Finland. The final factor, fear of computers revealed that the South African group was significantly different to the other two groups. As was previously discussed, the teacher-students in South Africa showed lower levels of computer fear than the other two countries.

4.8 Summary of Findings

Attitudes can be examined at different levels of generality, depending on the action, target, context and time elements being evaluated (Palaigeorgiou *et al.*, 2005: 331). To summarise the finding of this chapter, the three research questions were answered. The student-teachers did have a positive attitude towards computers. They appeared to be willing to use computers and when comparing the three groups with each other, the two African countries indicated more positive attitudes towards computers and indicated a greater willingness to

use computers than the students in Finland, despite or perhaps as a result of their increased computer access and Internet connectivity.

Chapter Five

Conclusions, Implications and Recommendations

5.1 Introduction

Mathematics is a subject that is often spoken about in all fields, and many efforts have been made to explore different ways of teaching the subject more effectively by designing different curricula, study material and using different pedagogical approaches. By using new technology in the classroom, there is promising evidence of a relationship among computer-supported activities, positive attitudes towards Mathematics, improving learning and ultimately student performance (Lopez-Morteo & Lopez, 2007: 618). There is a multitude of research on the attitudes of learners to technology and the pedagogical effect thereof as well as the specific influence on Mathematics learning. The purpose of this study was to ascertain what the student-teachers' attitudes are towards computers so that we can proceed to design Mathematics curricula in such a manner that ICT can be used as a reinforcing tool to improve and add value to the learning process, to improve the results of teacher-students and ultimately to make a difference in the Mathematics school classrooms.

This chapter provides a discussion of aspects that influence the attitude to computers of teacher-students in South Africa, Finland and Tanzania. These aspects include amongst others computer anxiety, confidence and liking, perseverance, Mathematics anxiety and confidence.

5.2 Summary of the Research

This study was a quantitative cross-sectional survey research design consisting of a single mode research questionnaire which was administered to teacher-students at three different educational institutions; in South Africa, Finland and Tanzania. The TPCK model which integrates technology in teaching and learning was used as a conceptual framework since the teaching and learning of Mathematics integrated with the knowledge of technology and of teaching and learning summarises the essence of this study.

5.3 Reflecting on the research

A brief review of the design and methodology of this study as well as the conceptual framework from which the research was done, will be presented.

5.3.1 Design and Methods

This study made use of quantitative data collected from 317 teacher students from the NWU in South Africa, 111 teacher-students at the Iringa University College, University of Tumbani in Tanzania, and 56 at the University of Joensuu in Finland.

One of the limitations of the study is the discrepancy between perceived ideas and actual ideas. Since many students do not own their own computers and are not that often exposed to computers, their responses could be biased in their lack of actual experience. The responses to the questionnaire could in many cases be perceptions of computer use and might not be a representation of actual skill and practice.

Another limitation in the study is the language proficiency of the teacher-students. For the majority of the teacher-students in the groups in Finland, Tanzania and South Africa, English is not their first language. In many cases English is a second or even third language. This creates a limitation in the comprehension of the questions on the survey. Although most of these students' tuition is in English, their lack of proficiency in the language could lead to misunderstanding and confusion. Van der Walt (1997), as well as Els, Van Eeden and Du Plessis (2010), found that South African respondents would rather surmise or speculate on difficult statements, than indicate that they do not comprehend the true meaning of English terms. To try to compensate for this anticipated problem, the researcher selected the Loyd and Gressard questionnaire as a measuring instrument because of its simple use of the English language, and because all responses were recorded on a Likert-type scale, no responses were open-ended where students were required to express their own thoughts and feelings in words.

5.3.2 Conceptual Framework

The TPCK model of Mishra and Koehler (2006) served as the conceptual framework for understanding the integration of technology knowledge with content and pedagogical knowledge. The Four in Balance Model (Kennisnet, 2009), also served as a conceptual framework; it claims that there needs to be a balance between vision, expertise, digital learning ma-

materials utilized and the ICT infrastructure. Figure 5.1 illustrates how these two conceptual frameworks complement each other. The amalgamation of the three dimensions of technology knowledge, pedagogical knowledge and content knowledge can only be appreciated and effectively implemented if the leadership and the educator have sufficiently liberal and exploratory vision to grasp these new ideas. Since vision refers to the school's view of what constitutes good teaching, the integration of the aspects mentioned above could to a large extent be the means to achieve it, by designing, organizing and adapting the school's policy.

The amalgamation of technology and content knowledge is knowledge about the relationship between technology and content. Teachers need to have subject matter knowledge and knowledge of technology and need to in an effective manner be able to integrate these two knowledge bases. In order to make this blend meaningful and significant, there needs to be an ICT structure in place: computers need to be available and the quality of networks and Internet connections will determine the success with which ICT can be integrated into Mathematics education. The manner in which an institution's electronic learning environments are maintained and managed also play an essential role in implementing ICT in Mathematics teaching.

Expertise has an influence on pedagogical content knowledge and technological content knowledge. Expertise in the Four in Balance model of Kennisnet refers to teachers and learners' sufficient skills and knowledge to use ICT in designing and organizing learning processes. The purpose of this dimension is to achieve educational objectives. Since pedagogical content knowledge goes beyond knowledge of only the subject and accentuates subject knowledge for the purpose of teaching, the effect of expertise on this dimension of knowledge can clearly be seen. It deals with expertise and knowledge of not only pedagogical techniques, but knowledge of students in the learning situation, their conceptions and misconceptions, their approaches and misapplication of prior knowledge. Figure 5.1 indicates my interpretation of how TPCK and the Four in Balance model support each other.

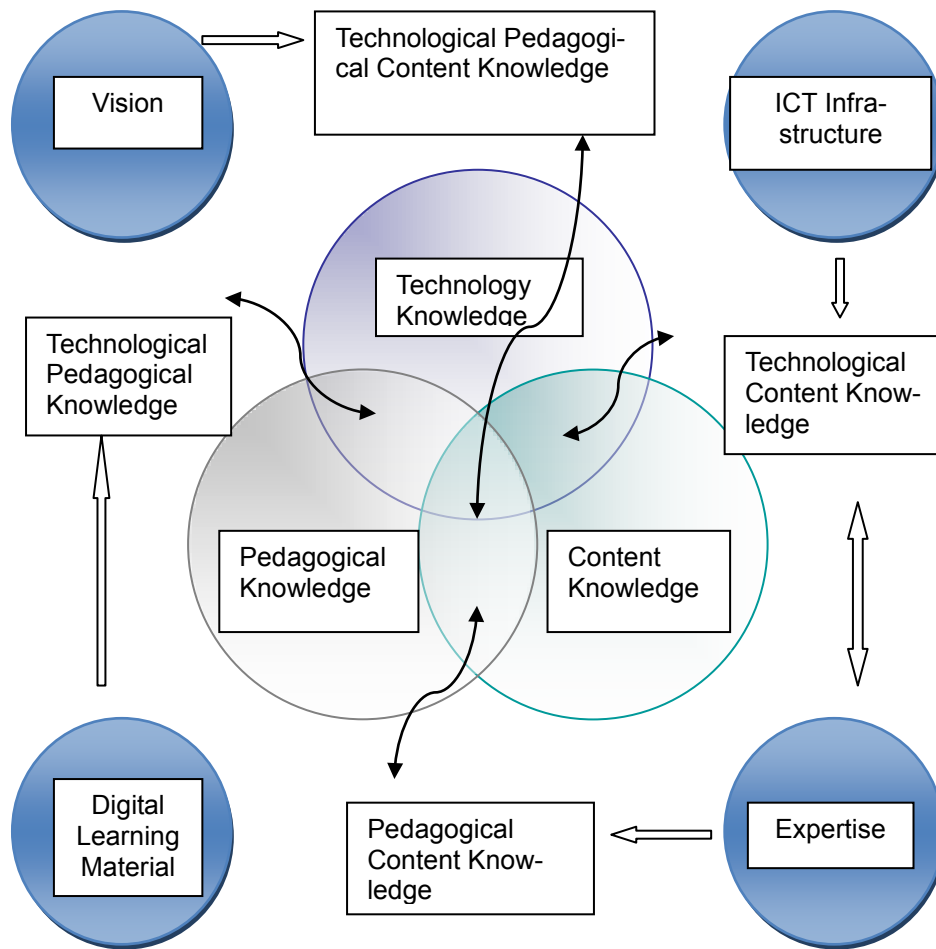


Figure 5.1 Representation of how the TPCK Model is Supported by the Four in Balance Model

Digital learning materials include all digital educational content (Kennisset, 2009: 12). The reason why I have linked it to technological pedagogical knowledge is because it is knowledge of the existence, components and capabilities of technologies in the teaching and learning climate. Knowledge of how to use these technologies to change teaching and learning also features strongly here.

5.4 Summary of the Research Findings

The research question: *What is the attitude of Mathematics teacher-students enrolled for the ACE in Mathematics course towards ICTs?* In order to answer this question, three sub-questions were designed and answered. To answer the first sub-question: *What is the attitude of Mathematics teacher-students enrolled for the ACE in Mathematics course towards*

ICTs?, descriptive statistics was used. In Chapter 4, three main themes were identified in order to answer this question. The main themes were computer anxiety, liking computers and computer confidence. Within those themes, a number of sub-factors that influence the main themes were discussed like willingness to engage in computer tasks, perseverance during computer use, attitude to problem solving with computers, the influence of affective factors, Mathematics anxiety, Mathematics confidence and perceived ability with new technology.

The results revealed that teacher-students did not show high levels of anxiety when working and dealing with computers. A factor that might influence computer anxiety is the mode of delivery of the questionnaire. Since most of the questionnaires were completed in a pencil and paper format, the absence of a computer might influence the outcomes of this specific theme. The teacher-students indicated that in general their computer liking was positive. They indicated that they were willing to do Mathematics on a mobile phone or computer. Although their computer access still needs attention, it appears to not be that poor. Worth noting is that external factors like time, family obligations, pressures from society and different cultural perspectives might also influence the degree to which teacher-students like computers.

The results also revealed that the computer confidence of the teacher-students' was relatively high. The computer confidence was discussed in two categories, namely actual confidence and expected or perceived confidence. Where the perceived confidence is much higher, the actual confidence, although not poor, is not that convincingly positive as other dimensions already discussed. Teacher-students' willingness to engage in computer tasks indicated high levels of agreeability, and their perseverance during computer use was also recorded as high, despite the challenging contextual factors of many of the students. It was found that the teacher-students' attitude to problem solving with computers was positive, although not that convincing. The influence of affective factors did not indicate a negative impact on the use of computers and subsequently on the computer attitude of the teacher-students. The two aspects of Mathematics that were investigated in the descriptive statistics were the teacher-students' anxiety and confidence towards Mathematics. Both results imply a positive ultimate attitude towards Mathematics since the anxiety levels were low and the confidence levels were high. These two aspects and the outcomes of the statistical analysis will hopefully positively influence the teacher-students' achievement in Mathematics. Teacher-students' perceived ability with new technology was revealed as positive, but with limitations.

The second sub-question that needed to be addressed was: *To what extent are these students willing to use computers?* With the aid of factor analysis, various factors were identified

and divided into two groups, namely enablers and barriers to determine teacher-students willingness to use computers. The barriers include the following three factors: lack of computer or Mathematics confidence; attitude to problem solving with computers and computer or Mathematics anxiety. Where these factors can be minimised as much as possible, the teacher-students willingness to use technology personally and in their school tasks will be much greater. The enablers include: perseverance; computer confidence; attitude to Mathematics and self-perceptions about technology. The same three themes that arose in the theoretical groupings (§ 4.3) were again evident in the factor analysis (§ 4.4), namely anxiety, confidence and liking. The positive responses within these themes are what assist in creating a positive attitude to ICT for Mathematics education and should be encouraged as far as possible.

The third research sub-question is: *What is the comparison of these attitudes with those of students in a developing and a developed country i.e. Tanzania and Finland?* This question was addressed by investigating descriptive statistics, and was discussed in the same categories as the first two questions. The computer and Mathematics anxiety and liking of the students in Finland was the highest, and that of the students in Tanzania and South Africa were very similar and was recorded as relatively low. The category of confidence also revealed that the Finnish students were not that confident, and of the two African countries, the Tanzanians appeared to be most confident with computers. The South African students were the most confident with Mathematics.

When analysing the teacher-students reaction to the enablers and barriers to create or deter willingness to use a computer, the findings revealed that the South African and Tanzanian students were the most willing to use computers since there were sufficient enablers to promote willingness and few enough barriers to deter willingness. The students in Finland were less willing to use computers.

Figure 5.2 provides a visual representation of the findings of this study. The ultimate goal is to investigate ways to improve and create effective Mathematics education. The use of technology in Mathematics education was the main focus of this project, and the benefits of technology for effective Mathematics education, were discussed in Chapter 2. Figure 5.2 illustrates how a positive computer attitude and Mathematics education together, with the assistance of the TPCK model can move towards more effective Mathematics education. It further illustrates what components were revealed in this study that affect and influence computer attitude and Mathematics education, as was discussed in Chapter 4.

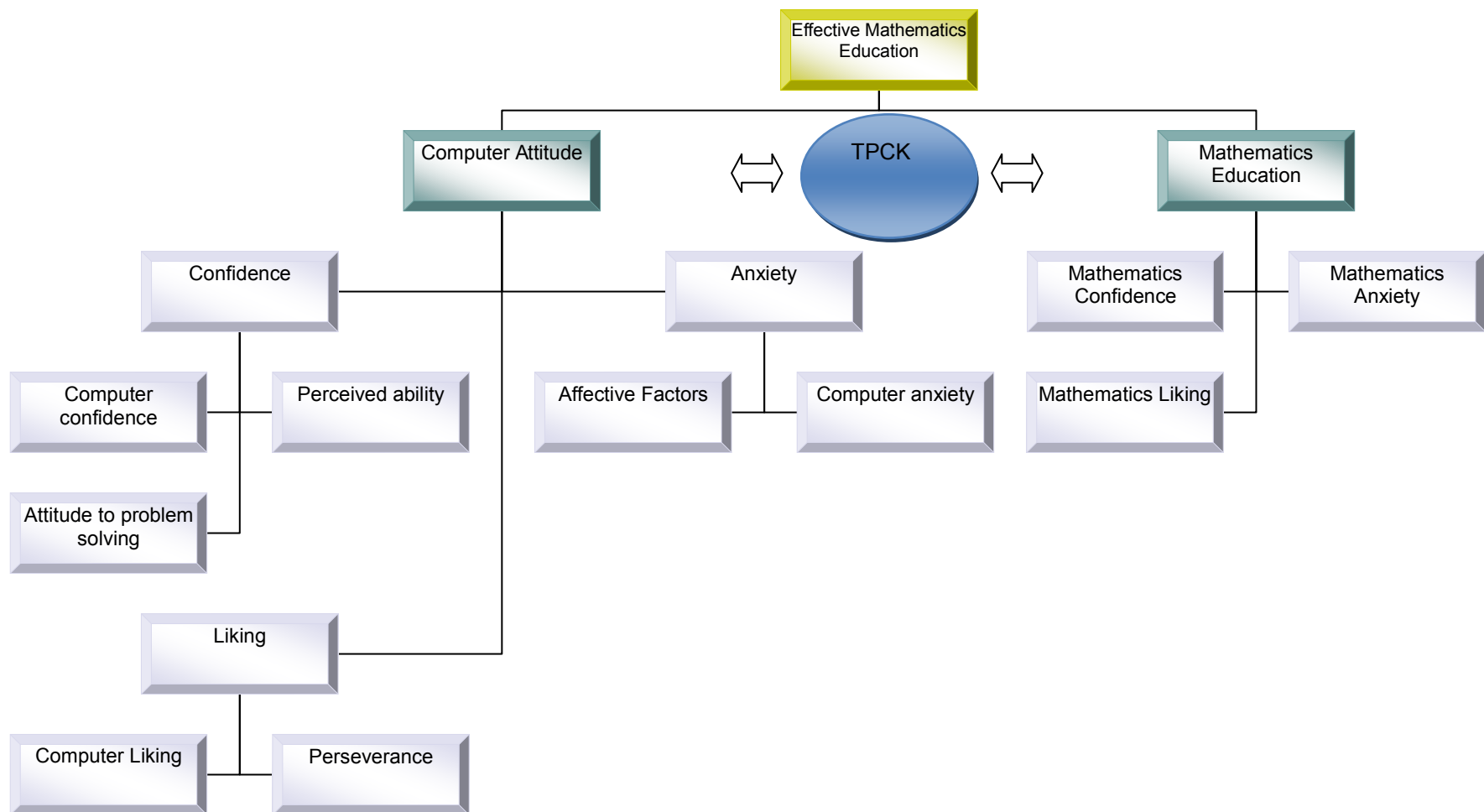


Figure 5.2 Illustration of Effective Mathematics Education According to this Study

5.5 Conclusions

The analysis and interpretation of quantitative data on teacher-students' attitude to ICTs provides the researcher with the opportunity to draw the following conclusions. The conclusions are based on evidence gathered and interpreted in the study and will be supported by literature from other studies.

Firstly, teacher-students have a positive attitude to computers and other technologies like mobile phones. Positive attitudes to ICT equip teachers to successfully integrate ICT into their teaching practice (Albirini, 2006; Meelissen & Drent, 2008; Pamuk & Peker, 2009).

Secondly, teacher-students are willing to use computers. Their willingness to use computers allows them to access the advantages of ICT in education. The benefits of ICT in teaching and learning are endless. ICT has transformed the outcomes of teaching and learning in experiences in classrooms. Not only does it complement and supplement teacher instruction, but offers unlimited access to knowledge and information (Kubiatko & Halakova, 2009: 743).

And finally, when doing a comparison between the three countries, we can conclude that the students in the two African countries (South Africa and Tanzania) have a more positive attitude to computers and Mathematics, and were more willing to use ICT, than the students in Finland. The Tanzanian students proved to be the most confident in computers and the South Africans were most confident with Mathematics, both of which were more confident in both aspects than the Finnish students. The Finnish students showed the highest levels of computer and Mathematics anxiety.

5.6 Recommendations

The purpose of this research was to determine what the teacher-students' attitude was to ICTs. The research is concerned with firstly establishing how teacher-students feel about computers and secondly making recommendations using the findings so that ICT can be used to improve the mode of delivery of the distance education courses at the SCTE at the NWU. In doing so, ICT can benefit teaching and learning not only at the SCTE, but since the students are full-time teachers in the classrooms of South Africa, teaching and learning in South African classrooms can also benefit from these results.

5.6.1 Recommendations for Policy

The South African national policy on ICT in Education has set out a number of phases in the White paper on e-education, August 2004, with regard to implementing ICT in South African primary and secondary schools. These phases are:

- Enhancing a system-wide and institutional readiness to use ICT for learning, teaching and administration (2004-2007)
- System-wide integration of ICT into teaching and learning (2007-2010)
- ICT should be integrated at all levels of the education system (2010-2013) (DoE, 2004: 39).

The South African white paper on e-education (DoE, 2004: 9) recognizes that Africa is a developing continent in which the lack of infrastructure for ICT's is widening the gap between Africa and the rest of the world. Africa has consequently adopted a renewal framework, the New Partnership for Africa's Development (NEPAD) which identifies ICTs as central in the struggle to not only reduce the continent's poverty, but also overcome barriers of isolation and increase access to information and education. NEPAD recognizes the role of ICTs in the establishment of regional distance learning and health education programmes to improve the health and education sectors. In order to do this, Africa needs to develop and produce a pool of ICT-proficient youth and students from which the country can draw trainee ICT engineers, programmers and software developers. The role of the SCTE in this process cannot be underestimated. Since the SCTE is concerned with training and upgrading the qualifications of teachers in South Africa using a distance education model, they can assist in overcoming the barriers that are created in Africa as a result of a challenged education system by providing teachers with essential skills and knowledge. The training of Mathematics teachers in particular, that are proficient in ICT as well is imperative if the desire is to produce students that can work in the field of engineering, programming and software development. It is these teachers that will be required to equip learners in the school classrooms with the necessary Mathematics and ICT skills they need to become leaders in essential fields like engineering and computers.

One of the aspects that was revealed in this study is that teacher-students are willing to use technology in their studies and teaching career, but would like to receive further training. To assist in closing the gap in the digital divide between Africa and the rest of the world, teachers need to be given the opportunity to be sufficiently trained in the use of technology, not in isolation, but as a tool to improve and enhance teaching and learning in general. Limited access and availability of technology and Internet access serves as a barrier to improving

Mathematics education with technology, and should be kept in mind when considering policies on ICT integration.

5.6.2 Recommendations for Further Research

Angeli and Valanides (2009) explored the construct of ICT-TPCK and adopted a transformative view of TPCK, concluding that it is a unique body of knowledge constructed from the interaction of individual knowledge bases, the development of one or more of which does not guarantee or imply a simultaneous development of ICT-TPCK. My recommendation is that this body of knowledge requires more investigation to fully understand exactly how teacher development programmes should be structured to improve integration of ICT in education.

Another recommendation is that further research should be done to determine if the environmental factors in Finland like air deprivation and also depression, has an effect on the residents' attitudes.

5.7 Value of the Research

The purpose of this research project was to determine how Mathematics education students feel about computers. Their attitude to computers determines the extent to which they are prepared to use computers in their own studies and in their teaching. There is a burning need to include technology in the mode of delivery of the courses presented at the SCTE, but before any such decisions can be finally made and implemented, it is essential to establish what the teacher-students feel about computers. If they are apathetic or fearful of computers, the switch to full-blown blended learning will have to seriously be re-evaluated. The value that technology brings to learning Mathematics is evident from the literature that has been presented in Chapter 2, and it clearly paves the way to start implementing technology in a more extensive manner than what is currently being done at the NWU. The purpose of the comparison of Mathematics education students across three countries was to note the comparisons and differences between a developed country and two developing countries at different levels of development. It is valuable to take note of the differences to improve on those that need improving and cling to the similarities that are of value.

5.8 Further Research

Due to the collaborative agreements between the North-West University in South Africa, the Iringa University College, University of Tumbani in Tanzania, and the University of Joensuu in Finland, this research can be performed on a regular basis to establish what the current situation is in terms of students' attitudes towards ICTs. It is important for the SCTE to ascertain to what extent their students are willing to use ICTs so that strategic planning can be done to incorporate the use of technology into the programmes that are presented. The research should also reveal exactly what type of technology the students would feel comfortable with, and also what technology they have access to.

5.9 My Research Journey

Although the Loyd and Gressard survey was designed and used for the first time in 1984, I believe that it very successfully served its purpose. Yushau (2005), Salzer *et al.* (2003) and Francis *et al.* (2000) have made use of Loyd and Gressard's CAS more recently with satisfying results. The simplicity with which the questions are asked in the survey provides the researcher with the basic information that is necessary to determine the attitudes of those being tested. With the inclusion of a few questions which related to more modern technology, I believe that a broad spectrum was covered with regard to ascertaining the populations' computer attitude even in 2010, and that it is valid to still use today.

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