PREDICTORS OF EDUCATION TECHNOLOGY'S EFFECTS ON IT STUDENTS' PERFORMANCE

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Vanderbijlpark

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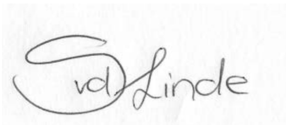
DECLARATION

I declare that:

PREDICTORS OF EDUCATION TECHNOLOGY'S EFFECTS ON IT STUDENTS' PERFORMANCE

is my own work, that all the sources used or quoted have been identified and acknowledged by means of complete references, and that this dissertation has not previously been submitted by me for a degree at any other university.



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OPSOMMING

Die doel van hierdie navorsing was:

- om die faktore wat IT-studente se prestasie beïnvloed, beter te verstaan;
- om te begryp hoe onderrigtegnologie kan help in die oorkoming van sommige van die faktore wat studenteprestasie negatief beïnvloed;
- om 'n beter begrip te verkry oor studente se persepsies oor tegnologie gebruik in die klaskamer;
- om die korrelasie te bepaal tussen onderrigtegnologie en studente se prestasie, en
- om vas te stel of die gebruik van hulpbronne wat beskikbaar gemaak is op 'n leerbesturrstelsel IT studente se prestasie voorspel.

Ten einde hierdie doelwitte te bereik, fokus die navorsing eerstens op 'n literatuuroorsig om faktore (probleme) te identifiseer wat 'n invloed het op IT-studente se prestasie en hoe sommige van hierdie probleme oorkom kan word met die gebruik van onderwystegnologie.

Tweedens bestaan die empiriese deel van die studie uit die data verkry uit 'n aanlyn-leerbestuurstel – eFundi™ – by die Vaaldriehoekkampus van die Noordwes-Universiteit in Suid-Afrika. 'n Vraelys was uitgegee as deel van 'n kollatorale ondersoek om studente se persepsies oor onderwystegnologie te bepaal. Die empiriese gedeelte van die studie is gedoen om begrip te kry van studente se mening oor onderwystegnologie, of die studente se persepsies verander het gedurende hul eerste semester en of die gebruik van sekere hulpbronne 'n invloed het op studente se prestasie het.

Die bevindinge uit die literatuur het aan die lig gebring dat denkraamwerke, leerstyle, wiskundige vermoëe, vorige programmeringservaring en geslag saam met ander voorspellers enkele van die mees prominente voorspellers is van sukses van IT-studente se prestasie. Die empiriese gedeelte van die

studie het aangetoon dat die gebruik van sekere hulpbronne studente se prestasie beïnvloed en dat studente ’n oorkoepelende positiewe persepsie van tegnologie het.

Laastens word aanbevelings gemaak vir verdere navorsing om die studie van onderwystegnologie uit te brei na voltydse BSc. IT-studente (en nie net vir verlengde BSc. IT-studente nie) by ander universiteite in Suid-Afrika.

SUMMARY

The aim of this research was:

- to gain a better understanding of factors that influence the performance of Information Technology (IT) students;
- to gain a better understanding of how Education Technology can assist in overcoming some of the factors that negatively influence the performance of IT students;
- to gain a better understanding of students' perceptions about technology usage in classrooms;
- to determine the correlation between the use of Education Technology and student performance, and
- to identify whether the use of resources posted on a LMS can serve as predictors of IT students' performance.

In order to achieve these objectives, the research used, firstly, a literature review to identify factors that influence the performance of IT students and how some of these problems can be overcome with the use of Education Technology. Secondly, the empirical part of the study consisted of data derived from an online Learning Management System called eFundi™ at the North-West University Vaal Triangle campus in South Africa. A questionnaire was issued as a collateral investigation to determine students' perceptions about technology use in classrooms. The empirical portion of the study was conducted to gain an understanding of how students feel about Education Technology, whether the students' perceptions have changed during their first semester about technology use and whether the usage of certain resources have an influence on students' performance.

The findings from the literature revealed that mental models, learning styles, mathematical ability, prior programming experience and gender are some of the most prominent predictors of success in the performance of IT students.

The empirical portion of the study revealed that the usage of certain resources influences students' performance and that students have an overall positive perception about technology.

Finally, recommendations are made for additional studies in order to extend the study of Education Technology to full-time BSc. IT students (not only BSc. IT extended students) at other universities in South Africa.

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CHAPTER 1
INTRODUCTION AND BACKGROUND TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND

It is well documented that learning to program is difficult for novices (Jenkins, 2002:29; Robins, Rountree & Rountree, 2003:137). In many Information Technology (IT) courses, such as programming, the subject material consists of a sequence of logical concepts that build on one another. Thus, a student who falls behind in the beginning will have difficulty with all subsequent course content. A possible reason why some students can't keep up is because they do not understand basic concepts in IT. The focus of higher education should not be on the acquisition of knowledge, but rather on teaching methods that support students in becoming worthy scholars with all the necessary skills (Laurillard, 2006:75) thus focusing on the application of concepts as well as the theory. It is therefore crucial that students should be engaged throughout the learning process.

Fortunately, Education Technology offers many ways to ensure such continuous engagement of students (Coles, 2009:1). According to the Association Educational Communications and Technology (AECT) (as quoted by Januszewski & Molenda, 2008:1), Education Technology is defined as follows:

> *"Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources."*

Education Technology can be utilized in classrooms not only to create a learning experience but also to overcome some physical barriers and shifting the focus from knowledge retention to its utilisation (Courville, 2011:3). However, the relative novelty of such technology implies that lecturers are often unaware of its potential for student engagement, and moreover, that students have widely varying perceptions of its value (Coles, 2009:1; Malm &

DeFranco, 2011:404; Šumak, Hericko, & Pušnik, 2011:2068). The value and success of an educational tool is not determined by the tool itself, but rather by the didactic appreciation and initiative of the facilitator, and the way in which the tool was implemented (Burke, 2005:10).

A focused study is proposed that will investigate the extent to which IT students benefit from the use of a selected Education Technology, more specifically, a learning management system (LMS).

1.2 PROBLEM STATEMENT

Programming is hard to learn, therefore drop-out rates are high and Computer Science enrolment is decreasing (Kinnunen & Malmi, 2006:97; Maloney *et al*., 2004:106; Sykes, 2007:223).

Tang and Austin (2009:1214) show that the rapid development of Information Technology provides rich resources and opportunities for changes in teaching and learning. Although the world is advancing rapidly in fields such as social networking, stem cell research and technology, Higher Education Institutions seem to change very little over time (Summers, 2012).

IT course content is challenging for students and not enough is done on order to progress to new levels of teaching and learning. Researchers have pointed out various predictors of success in IT and Computer Science courses, including mental models (Dehnadi, Bornat & Adams, 2009:11), learning styles (Lee, 1986:78), prior programming experience (Holden & Weeden, 2003:46), gender as a combination of factors and mathematics performance (Bergin & Reilly, 2005:415).

Education Technology can be used to overcome some of these problems encountered by students. Various technologies exist; our focus will be restricted to Learning Management Systems (LMSs), since most universities in South Africa use such systems extensively.

The basic problem that we wish to address is that Education Technology - such as a LMS - is not utilised to its full potential in IT courses. This will be done by gaining an improved understanding of the role that an LMS plays in the learning process. In particular, we wish to study the following research question: How can IT students' use of resources provided by a LMS serve as predictors of their performance in IT-modules at the Vaal Triangle Campus of the North-West University?

1.3 RESEARCH OBJECTIVES

In order to identify predictors of student performance through the use of education technology, the objectives described below will be pursued.

1.3.1 Primary objective

The primary objective is to identify predictors of student performance with the use of Education Technology, more specifically, a LMS used at the NWU Vaal Triangle campus. Theoretical objectives

In order to achieve the primary objective, the following theoretical objective needs to be addressed:

- Identify factors that influence IT student performance.
- Identify various Education Technologies that can help overcome some of the factors that influence student performance.

1.3.2 Empirical objectives

In accordance with the primary objective of the study, the following empirical objectives have been formulated:

- Determine the correlation between the usage of resources provided on a LMS and student performance.
- Determine whether the use of certain resources provided on a LMS predict student performance.

As a related objective, we also wish to investigate the students' subjective assessment of Educational Technology, both before and after exposure to an

LMS-based course offering. The degree of acceptance and successful use of an Education Technology such as a LMS depends on students' perceptions of the technology used (in this case a LMS); we would therefore also like to investigate whether the students' perceptions hold any correlation with students' use of the LMS and their performance

1.4 RESEARCH DESIGN AND METHODOLOGY

The study will consist of a literature review and an empirical study. Quantitative research, based on usage statistics derived from a LMS (eFundi^{TM}) and students' module and exam marks, will be used for the empirical portion of the study. A questionnaire will be used as a collateral investigation into students' perceptions about technology before and after they have completed a few modules.

The literature study will be done in order to determine the factors that influence the success in IT courses, and that of Education Technology.

1.5 CHAPTER CLASSIFICATION

After the current introductory chapter, our discussion will be organized as follows:

Chapter 2: Literature review: A detailed research of the predictors of beneficial Education Technology as well as the types will be provided and discussed.

Chapter 3: Research design and methodology: A detailed discussion of the methods that was applied in the research will be provided.

Chapter 4: Results and findings: This section entails a discussion on research findings, relevance thereof and how the literature study and the final results from this study coincide.

Chapter 5: Conclusions and recommendations: A summary of the findings will be presented and a conclusion on how the findings of the study contribute to filling the gap indicated in the academic research environment. The main contributions of the current work will be summarized.

1.6 CONCLUSION

IT is a difficult subject to learn and Education Technology offers many potential benefits. The primary objective of the study is to identify predictors of student performance with the use of Education Technology, more specifically, a LMS used at the NWU Vaal Triangle campus. In this study, a detailed literature review is performed in Chapter 2 in order to identify predictors of success in IT courses and looking at Education Technology examples that could possibly help overcome some of the problems students encounter. Although many such technologies exist, the empirical portion of the study's focus (Chapter 3 & 4) will be restricted to Learning Management Systems (LMSs), since most universities in South Africa use such systems extensively. As a collateral investigation students' perceptions will be gathered using a questionnaire before and after their first semester. Chapter 5 concludes the dissertation with a summary and a discussion of the limitations of our study and recommendations for future work.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, a detailed literature review is performed in order to identify predictors of success in IT courses and looking at Education Technology examples that could possibly help overcome some of the problems students encounter.

Section 2.2 introduces problems that affect the performance of students in IT. Section 2.3 looks more deeply into the literature in order to identify and discuss those factors predicting success or failure in IT modules.

Section 2.4 discusses Education Technology, the background, influences on the field and Education Technology as a predictor of success on the performance of IT students and Education Technology examples. With the use of technology in classrooms to overcome learning barriers, new challenges arise from the particular characteristics of the technology. Section 2.5 discusses some challenges students might encounter when using technology and finally Section 2.6 concludes the chapter.

2.2 PROBLEMS AFFECTING THE PERFORMANCE OF IT STUDENTS

Research reveals that students struggle with introductory subjects of IT courses from the onset of their studies (Jenkins, 2002:29; Robins *et al*., 2003:137). A substantial amount of research has been done in an attempt to identify predictors of success and failure in introductory programming courses. The literature reveals some of the most promising variables as gender (Rountree, Rountree, Robins & Hannah, 2004:102; Ventura, 2005:224), student's mathematical ability (Bennedsen & Caspersen, 2005:157; McCoy & Burton, 1988:160; Rountree *et al.*, 2004:102), abstraction ability (Bennedsen & Caspersen, 2006:40) and students' own beliefs (Wilson & Shrock, 2001:187). Robins *et al.* (2003:137) provide an extensive review on education in programming and pointed in the direction of Winslow's work.

Winslow (1996:17) looked at the psychological aspects of learning to program; he pointed out that novice programmers have poor knowledge organisation skills and are limited to surface knowledge of programming. Conceptual knowledge construction as well as the transformation of basic structures into plans is necessary to gain programming knowledge (Rogalski & Samurçay, 1990:170). Winslow (1996:17) concludes that novice programmers do not understand certain programming concepts and structures because they try to interpret each line of programming code separately, which is caused by poor mental models and further causes inadequate knowledge application to programs.

Factors predicting success in programming and Education Technology will be discussed in the sections that follow.

2.3 FACTORS PREDICTING SUCCESS IN THE PERFORMANCE OF IT STUDENTS

Taylor (2007:175) developed a model for factors that influence the success of technology-based subjects. This study was performed at North-West University in South Africa at the Potchefstroom campus. Firstly, she identified the factors that did not have an effect on success which included: mother tongue, race, socio-economical class, learning styles, future vision, time management and correct degree. Interestingly, factors that influence success in a technology-based subject include school performance, prior knowledge, gender, favourite school subject, and computer usage in work circumstances, computer anxiety and cell phone possession (Taylor, 2007:180-181).

The study done by Taylor (2007) yields conflicting results with those done by Nash (2009) and Seymour *et al*. (2004) in terms of mother tongue not having a significant influence on computer literacy skills. A reason for this might be because of the demographics of Taylor's study group. Taylor used a group of 2361 learners of which only 76 students' mother tongue was not Afrikaans or English (Taylor, 2007:176). The study group Taylor used, at the particular university (North-West University – Potchefstroom campus) does not represent the overall South African picture in terms of race groups: 91.5 per cent of students in Taylor's study group are classified as white, 3.7 per cent ware classified as coloured and 4 per cent as black. According to the Department of Education (2010:18), in 2007, 63 per cent of students enrolled at universities in South Africa were black, 24 per cent white and 6 per cent coloured.

Although the findings of Taylor (2007) are not related to IT specifically, there seem to be factors that apply to IT as well. In the sections that follow, the most prominent factors predicting success in IT identified in literature will be discussed.

2.3.1 Mental models

Mental models are knowledge which people possess prior to a task or acquire when performing a specific task (Reddy *et al.*, 2005:1051).

Novice programmers have misconceptions and difficulties because of non-viable mental models about key programming concepts which affect dropout rates – hence, dropout rates for introductory programming courses are sometimes the highest of all courses at higher educational institutions (Bayman & Mayer, 1983:677; Kinnunen & Malmi, 2006:97; Lahtinen, Ala-Mutka & Järvinen, 2005:14; Robins *et al.*, 2003:139). Lahtinen *et al.* (2005:17) interestingly noted in their study that novices tend to think that they understand programming concepts better than they actually do, which can be caused by misconceptions and non-viable mental models (Ma, Ferguson, Roper & Wood, 2011:57).

Dehnadi and Bornat (2006) claimed to have designed a predictive model for success in introductory programming looking at the use of different mental models of novices. The study claimed to measure a student's knowledge of sequence and assignment. Caspersen, Larsen and Bennedsen (2007:206) as well as Wray (2007:243) applied Dehnadi and Bornat's study and revealed that the predictions could not be repeated. Bornat, Denhadi and Simon (2008:53) agree that the predictive model did not live up to its promise. The study measured reasoning strategies rather than knowledge of sequence and assignment (Dehnadi *et al.*, 2009). Dehnadi *et al.* (2009) performed a new study at six universities (University of Newcastle, Australia; twice at Middlesex University, UK; at the University of Sheffield, UK; at the University of York, UK; at the University of Westminster, UK; at Banff and Buchan college, UK) and used the Winner procedure of meta-analysis to examine the effect of mental models and prior programming experience on student performance. Their study revealed that more than half of the novices that were tested are able to apply mental models consistently and build models spontaneously. The rest of the group could not build models or apply models consistently. The first group mentioned, performed better in the examination (Dehnadi *et al.*, 2009). An interesting discovery was that previous programming experience of novices hardly influenced their success. Consistency of mental model application remains the key factor to determining success according to Dehnadi *et al*. (2009:11).

Lecturers play a large role in non-viable mental models and should be able to identify signs of misconceptions early and correct them so that students are able to form viable models (Sorva, 2007:134). It is important to note that according to constructivism, knowledge will be constructed depending on the learning style of a learner which is discussed in the next section (Ben-Ari, 2001:46).

2.3.2 Learning styles

Learning styles refer to the many different approaches that students follow in order to make sense of and understand difficult material using a combination of characteristics such as emotional, physiological, intellectual, physical and personal characteristics (Ansalone & Ming, 2006:5; Bontchev & Vassileva, 2011:228).

There are many different learning styles and their relationships are quite complex. Several models have been developed over time in order to simplify understanding and categorize learning styles. The most common classifications used are the Myers-Briggs Type Indicator (MBTI) (Briggs-Myers & Briggs, 1985), Embedded Figures Test (Witkin, 1962), Honey and Mumford's Learning Style Questionnaire (LSQ) (Honey & Mumford, 2000), Kolb's Experiential Learning Model (ELM), Kolb's Learning Style Inventory

(LSI) (Kolb, 1984; Kolb, 1985; Kolb & Kolb, 2005) and the Felder-Silverman learning style model (Felder & Silverman, 1988).

Kolb's LSI was developed in 1976 based on the Experiential Learning Model (ELM) and revised in 1986. It was derived from work done by some of the great minds of learning such as Piaget and Dewey (Kolb & Kolb, 2005:6). It has been applied in various studies and is a well-known and widely used instrument used to measure learning styles (Baker *et al.*, 1988; Davie, 1987; Katz, 1988). The LSI which is represented in figure 2.1 is a Cartesian axis with four extremes, one at each end. The horizontal axis's extremes are based on how we do things: whether we like to be actively involved or take on a more observatory role. The vertical axis expresses how we think about things: whether we are emotional or more abstract. Based on these four extremes, each quadrant represents a learning style.

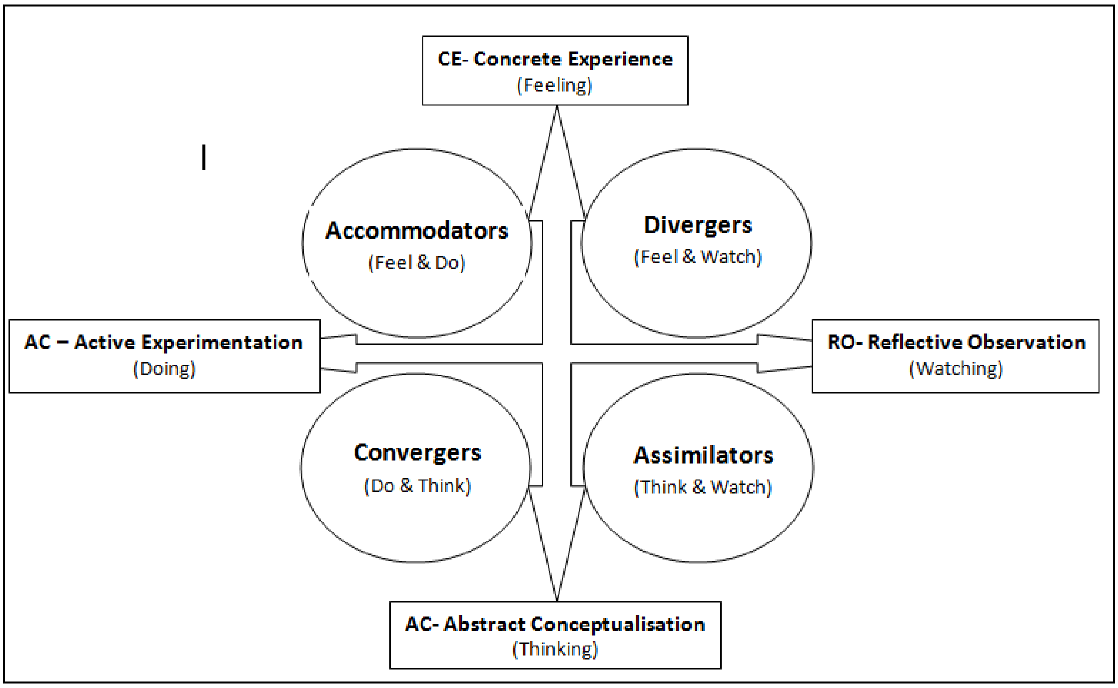

Figure 2.1: Kolb's learning styles [based on Sharp, Harb and Terry's (1997:94) representation of the learning styles of Kolb]

Kolb and Kolb (2005:5) describe the four learning styles as follows:

A person with a diverging learning style shows emotion and likes to take on an observatory role. They adapt to situations, generate ideas thus performing well in brainstorming sessions. They are emotional, have a great imagination and tend to take extensive interest in art. They are good listeners and perform well in group situations. This learning style corresponds with the Introverted Feeling type of Myers and Briggs (Kolb & Kolb, 2005:6).

A person with an assimilating style is observing and reasons logically. They differ from the diverging learning style individuals in the sense that they are not as interested in people, but focused more on abstract concepts. They focus on the theoretical logical aspects rather on practicality. This learning style corresponds to Myers and Briggs' Introverted Intuitive personality type (Kolb & Kolb, 2005:6).

A person with a converging learning style is a thinker and a doer. These individuals think about the theoretical aspects and apply it practically. Byrne and Lyons (2001:51) found that learners that possess a convergent learning style tend to perform better in objective evaluations than the rest as their strengths lie in problem solving, decision making and deductive reasoning. They will avoid social and personal conflict and rather spend their time on problem solving, working on new ideas and technical tasks. The converging learning style is similar to Myers and Briggs' Extravert Thinking type (Kolb & Kolb, 2005:6).

A person with an accommodating learning style is emotional and practical. They thrive on challenging tasks, act on emotions rather than logic and rely on other information rather than their own analysis. They are experimental with regards to new projects and prefer working in a group setting. The accommodating learning style corresponds to Myers and Briggs' Extraverted Sensing type (Kolb & Kolb, 2005:6).

A summary of the four different learning styles and their strengths are given in table 2.1.

Table 2.1: Learning styles (Taylor, 2007:56)

Learning style	Strengths	Concrete experience	Reflective observation	Abstract conceptualisation	Active experimentation
Diverger	(imagination and consciousness of the meaning and values)	✓	✓		
Assimilator	(problem solving and decision making)			✓	✓
Converger	(reasoning ability and theoretical models)		✓	✓	
Accommodators	(action, execution of plans)	✓			✓

Quality education, student achievement and satisfaction can be achieved when there is a match between learning activities and learning styles of students (Lee, 1986:78; Felder & Silverman, 1988: 675). One way to achieve this is to make use of web-based applications that are able to adapt to each learner's choice of learning style preference (Taylor, 2007:57). An example of this is when a student prefers visuals over auditory or sensory information (things you can see and touch) over intuitive information (insights and possibilities) (Felder & Silverman, 1988:675).

Learning styles and preferences of students have a direct relationship with students' culture, race and gender (Lee, 1986:80; Philbin, Meier, Huffman & Boverie, 1995:490).

Each person's learning experience is different to another. Kolb (1984:25) discusses six characteristics of experiential learning which is derived from the Lewin, Dewey and Piaget's models of learning.

In summary, the six characteristics of experiential learning are as follows: (Kolb, 1984:26-37; Kolb & Kolb, 2005:2):

1. Learning is a process and student engagement is one of the key factors of learning so that students can rebuild knowledge and receive feedback.

2. Learning is a continuous process where students should be encouraged to examine their current understanding and beliefs to be able to look at new ideas and integrate the old and the new to form better understanding.

3. The process of learning requires resolution of conflicts. When students encounter disagreement and conflict, it sparks thinking and reasoning about own beliefs and opinions which drives learning.

4. Learning is a holistic process as it involves everything of a certain individual, thinking, and feeling, perceiving and behaving.

5. Transactions between a person and the environment are involved in learning. Learning is self-directed and active that is applicable to everyday life.

6. Learning is a process of creating knowledge. This theory is based on a constructivist view of learning where knowledge is formed and reformed personally by a learner.

It is evident that learning is a process that is unique to each learner's behaviour, thinking and experience. Constructivism, on which the experiential learning model is based, claims that each learner will construct knowledge differently according to their prior knowledge, learning styles and personalities (Ben-Ari, 2001:46).

2.3.3 Gender

The gender gap in technology usage has long been a topic of serious discussion. Sackrowitz and Parelius (1996:37) reported that a gender gap exists in technology use. Males tend to have more experience and confidence with computers and technology than females. Males also have more computer experience and thus more confidence with computers than females when entering a higher education institution (Sackrowitz & Parelius, 1996:40; Scragg & Smith, 1998:85). A few years later Tsai and Tsai (2010:1185) reports on their study about Internet Self-Efficacy (ISE), it was found that girls use the Internet significantly less than boys and for totally different reasons. Girls use it more for communicative purposes and are confident using the Internet for those purposes whereas boys use the Internet to explore and confidently so. It was also suggested that girls and boys were more or less equally confident in using the Internet. Hence, it seems like the gap is narrowing to some extent.

With regards to IT performance Murphy *et al.* (2006:20) report that females, although they generally enter education having mastered fewer IT concepts than males, catch up during the course and at exit level they possess similar mastery levels to males. There is no significant difference in performance between males and females at the exit level of programming performance although it has been shown that males and females do (on average) differ in learning styles (refer to 2.3.2) (Bergin & Reilly, 2005:414; Lau & Yuen, 2009:705;; Pioro, 2006:125).

Gender as a stand-alone predictor of success in a programming course is inconclusive but a combination of factors working together is identified by Bergin and Reilly (2005:414) that accounts for a very large amount of variance in programming performance namely, how students think they understand programming, comfort level, gender and math score, which is discussed next.

2.3.4 Mathematical Ability

Mathematics is a part of science which is concerned with numbers, quantity and space which is either abstract or applied to subjects such as engineering, physics and others (Soanes & Stevenson, 2009:881).

Mathematics has a lot to offer to Computer Science (CS) courses, especially discrete mathematics (Byrne & Lyons, 2001:51; Ralston, 2005:8). There are various elements in mathematics that are used in Computer Science topics such as algorithm analysis and computational complexity. Students are often discouraged by the fact that they have to take Mathematics as part of their CS major because they do not see the value of studying Mathematics. Mathematics in isolation might not be valuable for students after all but Applied Mathematics such as discrete mathematics for CS becomes a rich resource when taught appropriately (Baldwin & Henderson, 2002:113).

Some researchers however, question mathematics in CS courses: this issue has been debated for many years (Ralston, 2005:6; Ventura, 2005:240). Ralston (1984:1003) mentions that Mathematics in CS is very important because it improves logical thinking required for software development and some graduates will need Mathematics in their careers or continuation of studies in CS. He also suggests discrete mathematics rather than calculus in CS (Ralston, 2005:9).

Konvauna, Wileman and Larry (1983:377) shares Ralston's viewpoint and conclude that having mathematics reasoning ability and background are very important for potentially succeeding in CS.

In conclusion Taylor (2007:181) shows that learners who prefer and perform in science-like subjects (Mathematics, Science, Computer Science) perform better than others in a technology based course. Performance in Mathematics and Science in general is a predictor of performance, success and persistence in a programming course (Bergin & Reilly, 2005:415; Byrne & Lyons, 2001:52; Katz, Allbritton, Aronis, Wilson & Sofa, 2006:51; Wilson & Shrock, 2001:187). Mathematics has been shown to be a predictor of success in CS because of its logical reasoning and problem solving, and discrete mathematics in particular is a valuable asset for CS students.

2.3.5 Prior programming experience

Students in introductory courses have often gained programming knowledge and experience through one of the following ways: programming courses, high school, work experience, clubs or self-study (Holden & Weeden, 2003:41)

Wilson and Shrock (2001) investigated various factors (gender, prior programming experience, math background etc.) that predict the success in

CS courses at a Midwestern university, and confirmed prior programming knowledge, comfort level within the course and mathematical ability as predictors of success in CS (Wilson & Shrock (2001:187).

Support for this notion is provided by Hagan and Markham (2000:28), who performed a study looking at previous programming experience and study of programming languages and found that the performance of the students correlated not only with the prior experience and study, but also the number of programming languages studied. The results clearly indicated the difference between experienced and non-experienced students.

Holden and Weeden (2003:46) reveal in their study that prior experience indeed makes a difference in performance but only in the first course; after that, students' performance seems to even out. The deeper the knowledge of prior experience, the better the students performed.

Both studies of Hagan and Markham (2000:28) and Holden and Weeden (2003:46) revealed that the prior language learned had no significant impact on the students' performance. However, Morrison and Newman (2001:181) do not agree. Morrison and Newman (2001:181) highlighted that students who had learned more than one programming language performed better than the rest. Prior knowledge in Basic had a negative effect on performance and prior knowledge in Pascal proved insignificant.

In conclusion, prior programming experience proves to be a significant factor in predicting the success in a CS course although some languages do not have a positive impact on CS performance as discussed above.

2.4 EDUCATION TECHNOLOGY AS A PREDICTOR OF SUCCESS ON THE PERFORMANCE OF IT STUDENTS

Tang and Austin (2009:1214) show that the rapid development of information technology provides rich resources and opportunities for changes in teaching and learning which can be used to address some of the problems highlighted in the literature. Göl (2012:2) indicates that each generation's expectations for technology in higher education increases, as people are increasingly familiarised with and exposed to technology. Education Technology can assist in overcoming some of the physical barriers associated with learning and at the same time create a learning experience (Courville, 2011:3). When students understand how to use knowledge gained, it will in turn help improve mental models held by students (Bayman & Mayer, 1983:677; Lahtinen *et al.*, 2005:14).

Education Technology and different instances thereof will be discussed in the sections that follow.

2.4.1 Education Technology Background

> *"Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources." (Januszewski & Molenda, 2008:1)*

The term educational technology has come a long way as it survived a sequence of different views and labels. These different views or paradigm shifts are categorised by Saettler (2004:7) into four categories as a) the physical science view; b) the communications and systems concept; c) the behavioural-science view and d) the cognitive-science perspective.

The first view of educational technology was the physical-science view of instruction technology and was also known as the media or hardware approach where Educational Technology (then labelled as audio-visual instruction) was seen mainly as aids in instruction. Most of the attention was on the features of the particular technology rather than on the learners (Reiser & Ely, 1997:65; Saettler, 2004:7). In the 1960s most leaders in the audio-visual instruction were no longer satisfied with the hardware approach and the first redefinition came about where audio-visual instruction changed to audio-visual communications. This is the first formal definition of Educational Technology that was recognized and formulated in 1963 by the National Education Association (NEA) by the Commission of Definition and Terminology of the Department of Audiovisual Instruction (DAVI) and was supported by the Technological Development Project (TDP) (Saettler, 2004:8;

Januszewski & Persichitte, 2008:259). The definition is given as follows (Ely, 1963:18): "*Audio-visual communication is that branch of educational theory and practice concerned primarily with the design and use of messages which control the learning process.*"

The new view of Education Technology (audio-visual communications) shifted focus from the technology itself to communicating information from either teacher or another resource to the learner (Saettler, 2004:9). Two additional definitions followed in 1968 when a more unfamiliar focus of the definition was described as a process of learning and teaching. This includes research on how students acquire knowledge as well as the improvement of instruction through the use of certain resources (Reiser & Ely, 1997:66).

The year 1970 proved to be an eventful year as DAVI changed its name to the Association for Educational Communications and Technology (AECT). In 1972, a new label was adopted with the name of "Educational Technology" and AECT announced a new definition; this time focusing on management of learning resources and educational technology (Reiser & Ely, 1997:68). The 1972 AECT definition is given as follows (quoted by Ely, 1972:36): "*Educational technology is a field involved in the facilitation of human learning through the systematic identification, development, organization and utilization of a full range of learning resources and through the management of these processes*."

A definition focussing on instructional technology followed in 1994 and the most recent definition was released and approved in 2004 by AECT: "*Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources."* (quoted by Januszewski & Molenda, 2008:1)

The field of Education Technology has developed over time and numerous influences affected its practise as time went by. In the next section the influences on the field will be discussed.

2.4.2 Education Technology influences

When thinking of the term “Educational Technology’, one tends to think about a physical tool to aid learning. A deeper look into the definition reveals that Education Technology is a field of study and not an educational tool (Hlynka & Jacobsen, 2009; Saettler, 2004:8). Education Technology as a study field requires continuous knowledge construction as well as a deep understanding of the field of Education Technology (Januszewski & Molenda, 2008:3). This viewpoint was not always supported. In the sections that follow, influences on the field Education Technology will be discussed.

In the 1950s behaviourism made an impact on the field of Education Technology and a foundation for a systems approach to instruction was formed when behavioural objectives were applied to the contingency management plans of the radical leader in behaviourism, B.F. Skinner (Saettler, 2004:14). The behaviourists focussed on the lower cognitive processes, and they believed that mental processes such as thinking, images and consciousness are simply not to be considered because they cannot be observed directly. Thus, when curriculums were created, they were created in a step-by-step manner that focussed mainly on immediate measurable learning products (Saettler, 2004:14). Skinner believed that students should be taught in a controlled environment, where they are introduced to new behaviours at a specific time and in a specific form (Saettler, 2004:14).

The focus of the field of Educational Technology has since shifted from instruction (control learning) to a field that strives to create a learning experience (support learning). For this reason learning has changed significantly, not only focusing on knowledge retention but also applying knowledge and skills in active use. This forms part of the cognitive constructivist view of instruction (Januszewski & Molenda, 2008:3; Saettler, 2004:14). The cognitive concept of educational technology became dominant in the 1980s and focuses on mental processes, thoughts and consciousness, the same aspects behaviourism chose to ignore (Saettler, 2004:14). The learner is seen as active and constructive and becomes an active participant for acquiring, understanding and using knowledge (Saettler, 2004:14).

An interesting study conducted by Perry in 1970 conveys that students initially thought that learning was just a process of reproducing knowledge, and gradually realised that learning can be more meaningful and personally rewarding when new ideas were formed by transforming knowledge and ideas based on their own previous experiences (Entwistle, 2000:2).

Educational technology should lead predictably to effective learning and be carried over to real-life applications with efficiency. Efficiency in a constructivist's point of view is not just reaching the goal in mind but rather understanding knowledge deeply and being able to apply it in real-world situations and thus also improving performance (Januszewski & Molenda, 2008:5). This idea is reinforced by the Aristotelian views of learning which is divided into two categories namely *epistêmê* and *technê* which implies that theoretical knowledge should be applied practically to real-world events rather than using pure reason (Göl, 2012:5; Saettler, 2004: 3). Various Education Technologies are discussed in the following section.

2.4.3 Education Technology Examples

2.4.3.1 E-Learning

E-Learning is defined as information and communications technology which is used to learn (Laurillard, 2006:71).

E-learning can make an impact: on how students learn, the pace at which they master skills, the availability of resources and the enjoyment factor of learning (Laurillard, 2006:72). E-learning also has other potential advantages for students:

1. Cultural: students feel more at ease with an interface they are used to using in other parts of their lives such as social networking etc.

2. Intellectual: It creates a platform for engagement in the sense that the technology used for social activity is now used for presentation of material and still allows for interactivity.

3. Practical: Resources are more accessible than ever. This makes time management and accessibility for students easier and participation could increase as a result.

4. Social: Online networking brings about a reduction in social difference and therefore it motivates greater responsibility for own learning (Laurillard, 2006:72; Matodzi, Herselman & Hay, 2007:69).

E-learning is designed with the intention of providing what the learner needs. It can provide the right information at the right time and place (Matodzi *et al.*, 2007:71).

In South Africa, some Universities have taken on E-learning projects in order to solve issues such as access to resources, large student numbers, and/or distance education. Most Universities have some form of a learning management system (LMS) either purchased or developed for own use. LMSs have different features according to a specific institution's needs. Features of a LMS include delivering course content, communication (e-mails, notifications, forums, instant messaging), assessments (tests, quizzes, assignment submissions), tracking student performance and management of online content (enrolment, resources such as timetables and other subject related resources) (Coates, James & Baldwin, 2005:19; Watson & Ahmed, 2004:5). Simply put, a LMS is a system that integrates a wide range of pedagogical and administration tools such as WebCT and Blackboard (Coates *et al.*, 2005:19; Watson & Ahmed, 2004:5). As with any technology integration in education, the effectiveness of the technology depends on various factors including the design, how it is integrated and the perceptions and attitudes of the users (Filippidi, Tselios & Komis, 2010:2; Malm & DeFranco, 2011:404).

The North-West University (NWU) uses a LMS called eFundi^{TM} which is powered by SAKAI^{TM}. SAKAI^{TM} is a widely-used Collaboration and Learning Environment (CLE) developed by an international consortium. It is a free and open source platform which is distributed under the Educational Community License (open source license). At the NWU the SAKAI^{TM} CLE is better known as eFundi^{TM} (Tredoux, 2012:79). At the NWU, eFundi^{TM} is used by lecturers and support staff to create course sites. The decision and responsibility to create a course site remains with the lecturer of the specific module. When such a site is created, the students that have registered for the relevant module are added to the site automatically. There are four roles that can be allocated to each user:

- Instructor - This user is normally the creator of the site and enjoys all the functionality and rights available in eFundi^{TM}.
- Additional instructor – The creators of the site can add additional instructors if they wish to do so. This is normally done when modules are shared between lecturers. The additional instructor has access to all the functionality and rights that an instructor has; however, the rights can only be altered by the instructor of the site.
- Teaching assistant – Teaching assistants are not automatically added, but can be added manually by the instructor. A teaching assistant's rights can be specified by the instructor and are generally more limited.
- Student – Students have limited rights and instructors have the ability to change students' rights.

When the lecturer creates a course site, a range of functionalities are available for selection for each site. The functionalities which are available for selection in eFundi^{TM} is given in table 2.2.

Table 2.2: Functionality available in eFundi^{TM} (taken from Tredoux, 2012:81)

Functionality	Description
Home	For viewing recent announcements, discussion and chat items.
Announcements	For posting current, time-critical information.
Assignments	For posting, submitting and grading assignment(s) online.

Functionality	Description
Chat room	For real-time conversions in written form.
Drop Box	For private file sharing between instructor and student.
eGuides	For authoring, publishing and organizing learning sequences.
Forums	Display forums and topics of particular site.
Glossary	Tool to create glossary.
Gradebook	For storing and computing assessment grades from Tests & Quizzes or that are manually entered.
Messages	Display messages to/from users of a particular site.
Polls	For anonymous polls or voting.
Resources	For posting documents, URLs to other websites, etc.
Schedule	For posting and viewing deadlines, events, etc.
Site Info	For showing worksite information and site participants.
Statistics	For showing site statistics by user, event or resource of the site.
Syllabus	For posting a summary outline and/or requirements for a site.
Tasks, Tests and Surveys	For authoring, publishing, delivering and grading assessments.
Tests & Quizzes	For creating and taking online tests and quizzes.
Web Content	For accessing an external website within the site.
Wiki	For collaborative editing of pages and content.

The *Home Page* provides the student with all the recent announcements from all the course sites available. The *Announcements* functionality is used by instructors of the site to inform students of any particular important information. The instructor is also allowed to attach documents in the announcements. *Assignments* can be used to create a date, time and space where students can receive instructions about an assignment and upload their assignments in the given time frame. The instructor can then access all the students' assignments in order to grade them. A *Chat Room* can be set up to encourage students to interact with each other in real-time. The *Drop Box* functionality allows users and instructors to share files privately. The *eGuide* functionality can be used by the instructor to set up an on-line study guide where learning activities and content can be organised in the desired order. The *Forum* functionality can be used by the instructor to set up forums about certain topics to encourage debate between students. The instructor can follow each of the student's contributions to the discussions on the forums. A course can create a glossary using the *Glossary* functionality. The *Gradebook* functionality is used to keep record of all the students' grades. Items can be imported from a spread sheet or grades will be sent to the *Gradebook* automatically when a test/quiz in *Test & Quizzes* were set up and the option was selected by the instructor to send the item to the *Gradebook*. Students and instructors can send messages to site participants using the *Messages* functionality which works in a similar fashion to email with folders Received, Sent, Deleted and Draft. The *Polls* functionality is used to gather opinions from students in a quick and easy manner by posting a question and options of which they can choose. The *Resources* functionality is used to post any course relevant documents, web links, videos etc. A schedule can be set up with all the relevant course deadlines and important dates using the *Schedule* functionality. The instructor can personalise and manage the course site using the *Site Info* functionality. Participants can be added, removed and assigned different roles here by the instructor. The site's information can be personalised here, functionalities can be added/removed and the tab order can be set (different course sites). The *Statistics* functionality keeps track of each user's activities on the site, for example, how many times a user viewed certain files etc. The *Syllabus* functionality is used to post the outline and/or requirements of a particular module. The *Task, Tests & Surveys* functionality is used to post tasks, tests and surveys to students where an open date, due date and accept until date is taken. The instructor can set up questions and instructions within this functionality and students can complete and/or attach their documents for submission. The *Web Content* functionality allows the instructor to post links to websites so that students can access it within the site. Lastly the *Wiki* functionality allows collaborative work within the course site between students and the instructor. The lecturer can add or remove any one of the functionalities when the course site is created. Additional functionalities can be added after creation of the course at any time as needed.

In summary, a LMS improves the efficiency of teaching and provides an enriched learning experience for learners (Coates *et al.*, 2005:25). It also provides lecturers and students with many tools and the convenience of having access to the LMS with all its resources online.

2.4.3.2 Interactive graphics programming environments

Many students struggle with programming for various reasons as discussed in section 2.2.3. Some of the students are not strong problem solvers. Another problem highlighted is that students have great difficulty learning how and why programs solve a given problem; therefore the students face challenges with the writing, testing and debugging of programs (Cooper, Dann & Pausch, 2000:109; Kelleher & Pausch, 2005:86). This problem is addressed in the South African National Curriculum Statement and CAPS document for Information Technology. It states that sixty per cent of time should be spent on solution development, thus problem solving while developing applications from grade 10 to 12 which is a substantial increase compared to prevalent practise (Department of Education, 2011:9). Animations of written programming code's execution can help students to form the correct mental model and thus improve understanding (Cooper *et al.*, 2000:109).

There are a number of interactive graphics programming languages available. One of the older and more popular languages was Karel, The Robot (Pattis, 1996:72). Karel has since upgraded into a more sophisticated version called Karel++ which is similar to C++ but requires a higher skill level than before (Cooper *et al.*, 2000:111).

Some of the other interactive graphics programming environments that are designed to aid in problem solving and algorithms development will be discussed in the following sections.

2.4.3.2.1 Scratch

In an interview with Mrs. Malie Zeeman (a lecturer from the North-West University of South Africa and co-author of several *Enjoy Delphi* books for grade 10-12 IT learners) in 2012, it was revealed that a group of Information Technology (IT) educators formed a formal group "concerned group of educators" in South Africa. This group expressed great concerns regarding the decrease in enrolment in IT at the end of grade 9 for grade 10 to 12. Another concern was that there is a decrease in the enrolment of IT education students at tertiary institutions as well. A conference was held by the group and Mrs. Zeeman suggested that Scratch be used to address the problem.

The Curriculum unit of the Department of Basic Education then decided to use and implement Scratch in 2012 for grade 10 learners as a fun tool to teach programming (Zeeman, 2012). Scratch is a graphical programming teaching tool used to teach computational skills, concepts, algorithm development, problem solving and programming (Department of Education, 2011:13).

The designers of Scratch had a few criteria in mind that had to be met in order to be a successful tool. Some of the design criteria state that it must appeal to youth, their passions and be easy to get started and progress to higher skill levels gradually (Maloney *et al.*, 2004:106).

Scratch's graphical user interface (given in figure 2.2) is on a single window with multiple panels. It allows for easy access to all the controls. The command blocks are categorised and colour coded in the top left corner, with the selected category's commands available in the bottom left panel. The panel running in the centre of the screen contains the script with all commands as put together by the user. The user is able to test his/her script at any point in time. On the top right panel the sprite is found, and all actions are performed there as laid out by the script. Sprites and graphics can be changed and inserted on the bottom left panel.

When the user runs the script, the particular piece of script is highlighted as it is executed. There are no error messages as provision has been made so that the command blocks only fit in logically correct ways (Maloney, Resnick, Rusk, Silverman & Eastmond, 2010:2-7).

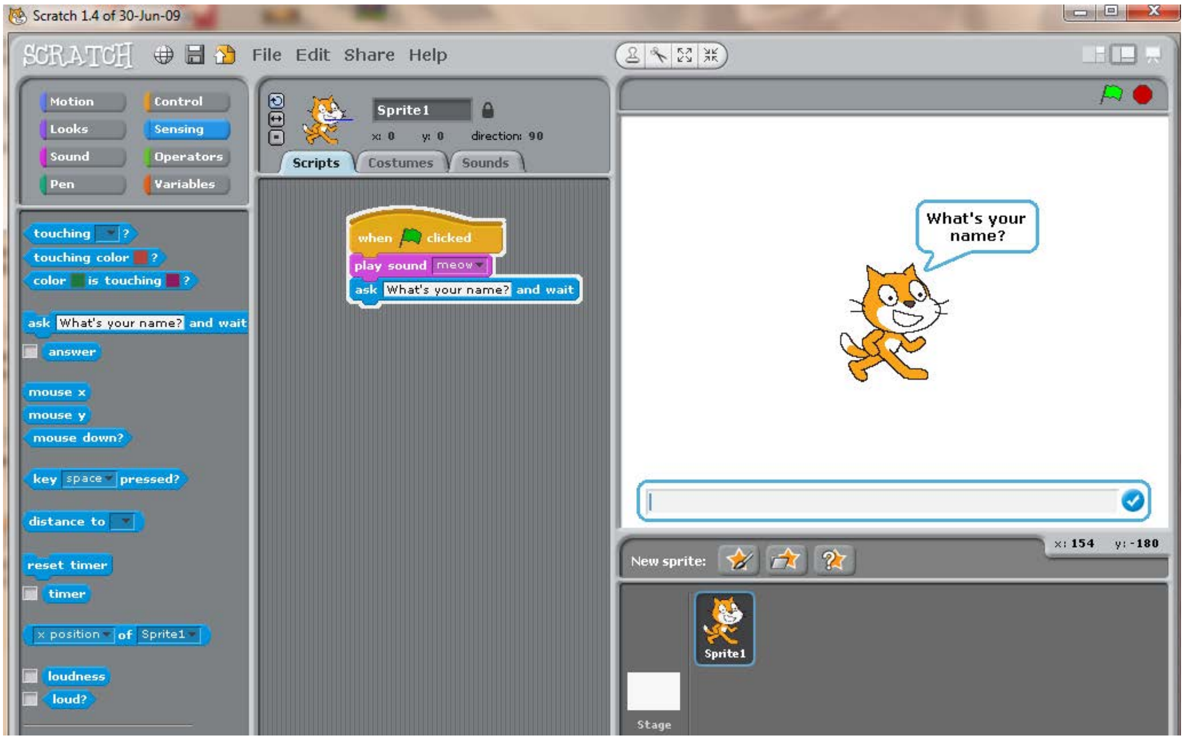

Figure 2.2: Demo Scratch program

In summary, Scratch provides users with the opportunity to use repetition loops, decision structures, and an engaging interface, learn algorithmic development and a syntax-free environment. It is a fun way of learning programming concepts and problem solving (Maloney *et al.*, 2010:5-15).

2.4.3.2.2 Alice

Alice is a rapid innovative prototype environment similar to Scratch developed by Carnegie Melon University (CMU). Alice gives students the opportunity to create animations, stories and interactive games using a simple to use drag and drop environment (See figure 2.3).

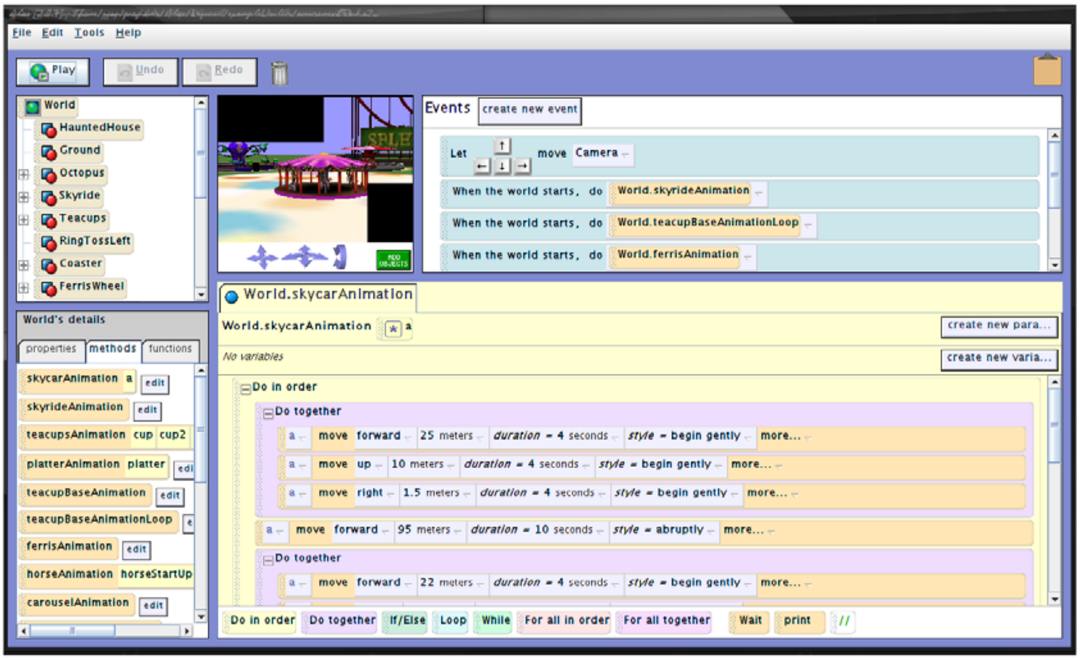

Figure 2.3: Demo Alice program (McGrath, 2008)

This allows students to focus on learning and enjoying programming constructs rather than worrying about syntax. Alice provides students with 3-D objects such as people, cars and animals, with properties that can be changed as desired to create a virtual world. The statements that students are allowed to use correspond to Python, Java, C++ and C#. Similarly to Scratch, the students are able to execute their program immediately to see how the particular code manipulates the objects (Daly, 2009:1; Moskal, Lurie & Cooper, 2004:76; Pausch *et al.*, 1995:8-9).

When using Alice, students are exposed to object oriented principles early on (Pausch *et al.*, 1995:9). Students can create their own methods, functions, learn recursion, decision making as well as loops. The Alice 3 release can be viewed directly in Java code and vice versa (Seidman, 2009:345). Alice is compatible with Windows, Mac and Linux platforms (Daly, 2009:1).

Moskal *et al.* (2004:79) found that with the use of Alice, performance, retention rates and attitudes in and toward computer science improved. They also found that students who are not likely to pass the module, but had participated in Alice schooling, performed better than students who are not likely to pass that had not interacted with Alice. These students with low marks that participated in Alice-based learning showed major improvement in their attitudes toward computer science.

Bishop-Clark, Courte, Evans and Howard (2007:206) introduced Alice to their students for two and a half weeks and discovered in their study that it improved their students' performance in programming drastically. Cooper, Dann and Pausch (2003:194) indicated that 91 per cent of students who took Alice in CS 1 continued to the second programming course (CS 2) and only 10 per cent of the control group who did not take Alice continued to CS 2.

Daly (2011:28) discovered that students who learned with Alice had higher levels of confidence after the completion of an introductory programming course than other students; this is also an important predictor of success indicated by Bergin and Reilly (2005:414).

2.4.3.2.3 Interactive graphics programming environments summary

Alice and Scratch are similar tools for teaching introductory programming. Both make use of drag-and-drop tools, which let the programmer focus on the coding, logic and algorithms rather than syntax. Other interactive graphical programming environments are available. Jeroo is a narrative type language but the user needs to enter code instead of dragging a command into position. Frustration can set in when commands are mistyped, taking time away from concept learning. RAPTOR and JHAVE are used to visualize algorithms. Although the concept is agreeable, it might not be particularly suited for introductory courses (Daly, 2009:5).

2.4.3.3 Serious games

"Serious games" are defined as follows: "*a mental contest, played with a computer in accordance with specific rules that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives*." (Zyda, 2005:26). Zyda continues stating that games become serious when pedagogy is added and this includes activities that lead to education or instruction and therefore learning knowledge and skills.

Simply put, a serious game is any digital game used for something other than mere entertainment (Muratet *et al*., 2009:2; Susi *et al*., 2007:1).

In table 2.3 Susi *et al*. (2007:6) provide a comparison between a game and a serious game. There are significant differences between a serious and entertainment game, the main differences being that an entertainment game is all about fun, enjoyment and simplicity whereas serious games have a clear goal to instil specific learning goals inside the game.

Table 2.3: Differences between entertainment games and serious games (Susi *et al*., 2007:6)

	Serious games	**Entertainment games**
Task vs. rich experience	Problem solving in focus	Rich experience preferred
Focus	Important elements of learning	To have fun
Simulations	Assumptions necessary for workable simulations	Simplified simulation processes
Communication	Should reflect natural (i.e., non-perfect) communication	Communication is often perfect

Serious games are becoming more popular and provide an opportunity to meet learning objectives (Corti, 2006:5; Muratet *et al.*, 2009:10). The learning outcome is dependent on the pedagogy, the rules and constructs of the game and how the learning content is combined with the fun element to form the game (Ulicsak, 2010:5). It is often used for training as students get to experience certain situations and get to react upon those situations without the real consequences like safety, cost and time. Serious games can be applied not only to programming and education but to areas such as healthcare, corporate and government (Susi *et al.*, 2007:1; Ulicsak, 2010:5).

Training simulations are used in the military. This is a cost effective, safe solution for training soldiers how to deal with certain situations, whether hazardous or just not feasible at the specific location. It saves money and labour and the fact that the simulations are so close to reality (high fidelity) makes it a feasible solution for soldier training (Stone, 2008:22-27).

In the health sector, as in the military, the use of simulations is growing. It is a cost-effective way to train surgeons, doctors and other medical personnel. Resources such as time and work-force are also spared as role playing consumes significant time and actors. There is a great lack of psychological fidelity; in other words, the actors are not able to mimic the reactions that the real situation would cause (Stone, 2008:27) when trainees have to train on actors (Ulicsak, 2010:6). Figure 2.4 demonstrates an example of early clinical procedure trainers.

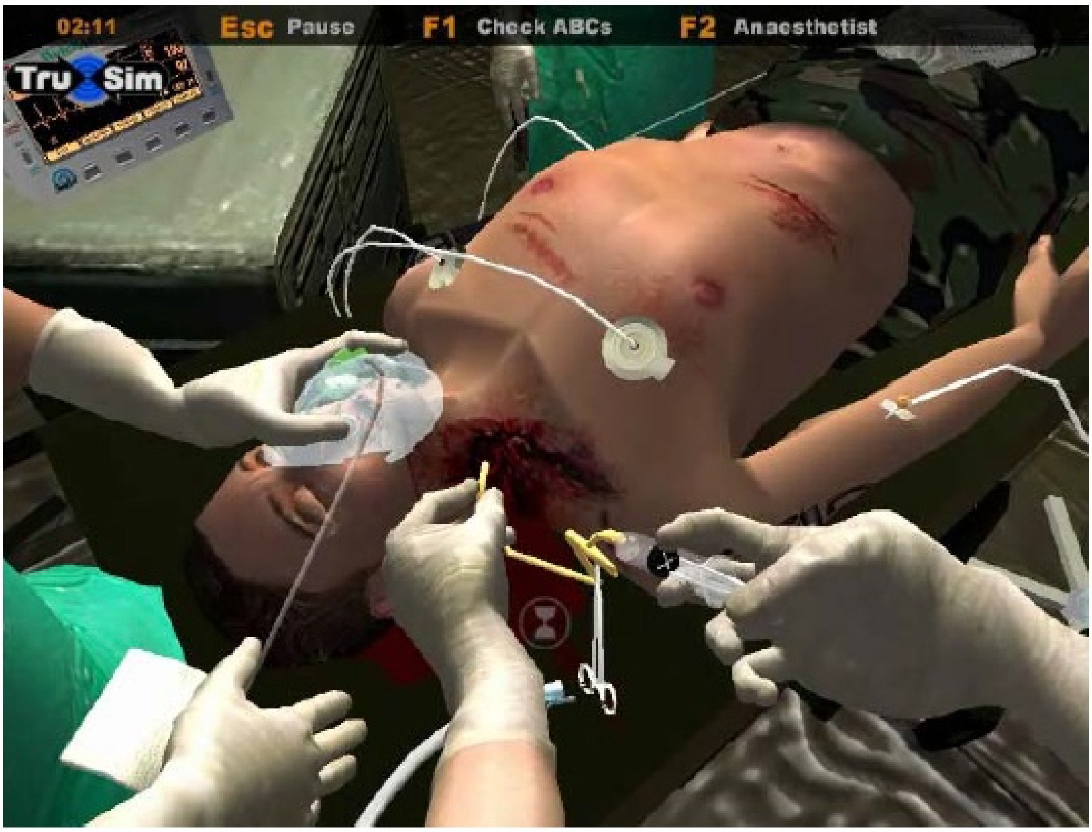

Figure 2.4: Screenshot of ITT demonstrator (Stone, 2008:21)

In education, specifically programming education, students often consider curriculum content as “boring”. Students are not motivated by curricula, yet they love games, therefore Prensky (2003:1) suggests a merge of the two called Digital Game Based Learning (DGBL). According to the definitions given in this section and Prensky's description, it serves the exact same purpose of serious games, games for a specific educational goal.

There have been various attempts (ColoBot, CeeBot and KuMir) of creating serious games for the purpose of learning how to program. ColoBot, CeeBot and KuMir are not particularly suitable for learning how to program and they make use of specific languages, or require advanced programming to play (Artificial Intelligence Competition Games) (Shabalina, Vorobkalov, Kataev & Tarasenko, 2009:65).

The fact remains that games get students' attention, and get them motivated and excited; thus attaining much that educators have been striving for in the classroom (Prensky, 2003:2).

Papastergiou (2009:10) compared a games approach and a web-based application for teaching memory concepts to CS students. The study revealed that the games approach proved to motivate learners more as well as improve performance better than the web application. Similar findings are supported elsewhere in the literature (Klawe, 1999; Rosas *et al.,* 2003; Shabalina *et al.*, 2009; Virvou, Katsionis & Manos, 2005).

Shabalina *et al.* (2009) developed a serious game with a theme of a Role Playing Game (RPG) aimed at undergraduate students. The main character in the game is a transformer that lives in a virtual world. The transformer can change shapes as necessary to move around in the virtual world.

In the game setup prior to playing, the player must enter his/her own data and choose appropriate data types for every field. Data types can be chosen from a list containing descriptions and purposes for every data type. Afterwards a class has to be created with the fields that were just entered. Functions, arrays and other fields are then added as the game progresses, starting with the writing of a function to move the transformer. The transformer is not able to do any movement until programmed to do so. The student has to program functions in order to move, jump and attack. The student will then use the programming in the game in order to progress. If the code is not effective, foolish or unreasonable, the game lets the player know that he/she must improve the code. The players are able to see their code execute.

Shabalina *et al.* (2009:70) believes that this game not only motivates learning, improves knowledge and skill but allows for step-by-step learning of object-oriented concepts using C++ as well.

In conclusion, when serious games are designed, aspects such as background of the student (language, age prior experience), learning goal of the game, which level of fidelity is needed, how knowledge can be assessed and whether it will be engaging have to be considered (Ulicsak, 2010:68).

2.4.4 Education Technology summary

The basic perspective of Education Technology is that performance can be improved by using available technological processes and resources efficiently (Januszewski & Molenda, 2008:9), to stimulate creative thoughts and applications. Hlynka and Jacobsen (2009) mention that "creating, using and managing" in history refers to three different people, a writer, director and an artist whereas in the 21st century creating, using and managing can be done by one person easily with the help of simple video-editing software, a laptop, network connection and webcam to upload videos for the world to see. An example of this is the Carnegie Mellon University Open Learning Initiative (OLI). A strong and healthy learning environment is created by the OLI by using intelligent tutoring systems, virtual labs, simulations and frequent assessments and feedback (Thille, 2010:74). The OLI produced convincing results, where learners mastered knowledge in half the time of ordinary ways. Students studying through online courses demonstrated the same outcomes or better than the traditional students (Thille, 2010:75). This is yet another example to prove that technology which is utilized efficiently can aid in the improvement of performance.

2.5 CHALLENGES STUDENTS ENCOUNTER WITH REGARDS TO TECHNOLOGY USE

The use of ICT has increased dramatically in Higher Education (Westera, 2004:504); however some students still lack the necessary ICT ability to complete university assignments (Egan & Katz, 2007:36). Some inequalities towards ICT literacy are identified by various studies done in South Africa, some of which include females, diverse student populations, racial groupings and learners who do not have English as their mother tongue (Nash, 2009:91; Seymour, Hart, Haralamous, Natha & Weng, 2004:105; Nel, 2010).

A study done at the University of Cape Town (UCT) showed that 74 per cent of all first years passed their computer literacy test. A large portion of the students who need more attention in this department are Africans and females. In conclusion to this study, Nash (2009:91) states that many of the students entering South African Universities do not possess the necessary computer skills, and that the universities need to intervene and support first-year students, especially African students.

The discussion on students' use and challenges of using technology should be placed in the broader context of technology adoption (Malm & DeFranco, 2011:404). Davis (1989) developed the Technology Acceptance Model (TAM) which states that technology is adopted by users depending on a) how useful they think that technology is, b) how easy they think it is to use the technology and c) their perceptions/attitudes towards the technology. TAM is one of the most popular theories used in research especially in e-learning acceptance studies (Šumak *et al.*, 2011:2068)

2.6 CONCLUSION

The literature revealed that mental models, learning styles, mathematical ability, prior programming experience and gender together with other predictors are some of the most prominent predictors of success in the performance of IT students. Many tools have been developed to overcome some of the problems that are associated with the different predictors. Education Technology forms a significant part of the available tools. Some of these tools include E-learning, interactive graphics programming environments (Scratch, Alice) and serious games.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In this study an online learning management system, eFundi™, was used to provide BSc. IT extended students with various resources in order to identify whether the usage of those resources could be identified as potential predictors of success.

The sample selection process for this study is discussed in section 3.2. In section 3.3 the data collection will be discussed and in section 3.4 the data analysis. Lastly, the conclusion will be given in section 3.5.

3.2 TARGET POPULATION AND SAMPLE

The target population includes IT students from universities in South Africa that have demographic backgrounds representative of the changes in democratic South Africa. Table 3.1 shows the race and gender breakdown for students enrolled in the BSc IT full time program for 2011 at NWU Vaal's campus. The BSc IT full time students in 2011 are represented in minority by Coloureds (2%) and Asians (5%). Whites (23%) represent the third most and Blacks (70%) are in majority. The BSc IT extended program was only represented by White (9%) and Black (91%) students.

Table 3.1: Race and gender breakdown for BSc IT students, 2011 (NWU, 2013)

	BSc IT full time (3years)		**BSc IT full time extended (4 years)**	
	Male	Female	Male	Female
Asian	4%	1%	0%	0%
White	17%	6%	7%	2%
Coloured	1%	1%	0%	0%
Black	46%	24%	38%	53%

In figure 3.1 the home languages of the BSc IT full time students enrolled for 2011 are shown. It is clear that these students come from various cultures and backgrounds, and that the race and gender representation are similar to those of the overall South African population (though still somewhat biased towards white males in the 3-year program).

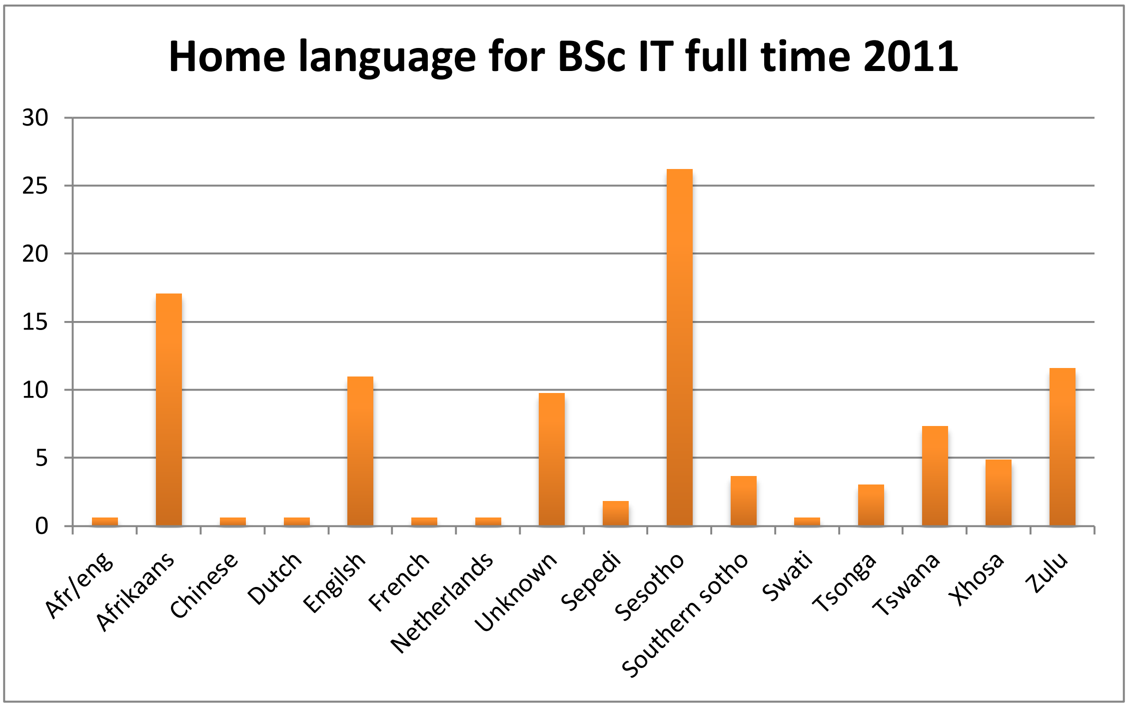

Figure 3.1: Home language breakdown for BSc IT full time students (NWU, 2013)**.**

The home languages for the BSc IT extended students enrolled for 2011 are shown in figure 3.2. Sesotho is the most spoken home language for this group of students.

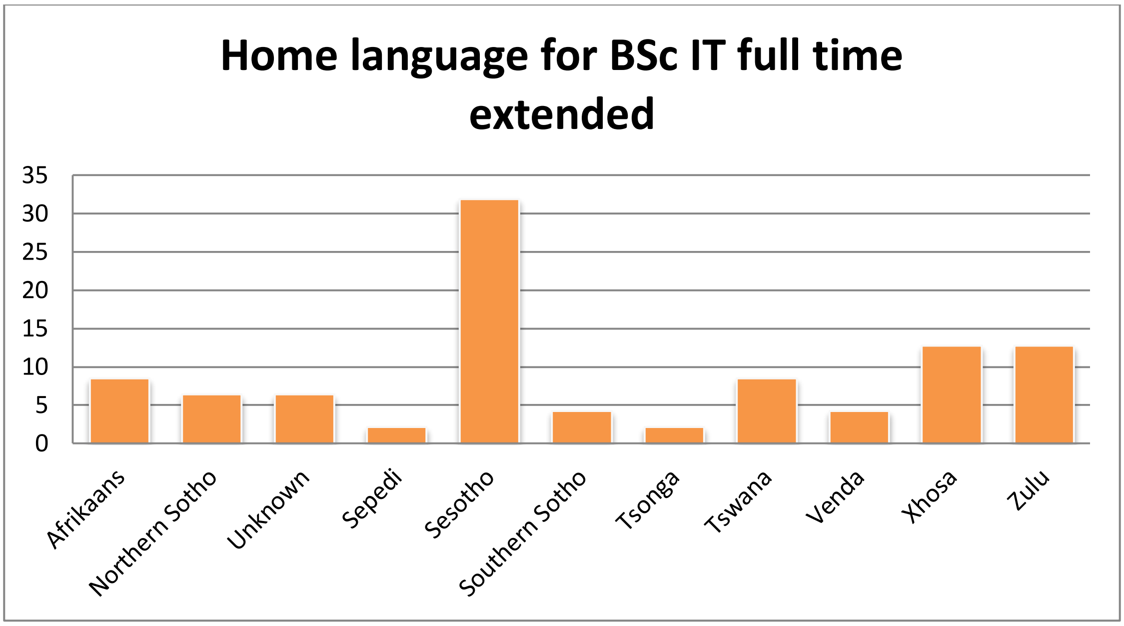

Figure 3.2: Home language breakdown for BSc IT extended students (NWU, 2013)**.**

The sample we will be using most extensively consists of 38 (21 female and 17 male) BSc. IT extended first year students at the North-West University Vaal Triangle Campus in South Africa. The extended program provides students who did not qualify for the BSc. IT program (3 year qualification) with another opportunity to enrol in the BSc. IT extended (4 years) program. Students are enrolled into the extended program when they have a Mathematics mark for grade 12 lower than 50.

A pilot study was performed on 11 second year BSc. IT extended students (9 females and 2 males) on the same campus in order to test the data collection tools.

3.3 DATA COLLECTION

The students completed a questionnaire which aims to measure students' perceptions of technology in the classroom and were also introduced to eFundi^{TM}, an online learning management system used at the North-West University. Students' exam and module marks were also captured for data analysis.

3.3.1 Questionnaire

The questionnaires were issued to 38 BSc. IT extended students (See Annexure A). The intention of the questionnaire was to determine whether students' perception about technology integration in the classroom has changed from the start of their first semester to the end of their first semester. The questionnaire was not intended to measure students' perceptions of eFundi™, but rather students' perceptions about technology integration in the classroom in general. Its use is motivated by the fact that students' acceptance of a technology is influenced by students perceptions thereof (Malm & DeFranco, 2011:404; Šumak *et al.*, 2011:2068). It is presented here not as a direct investigation into our main research question, but as a possibly interesting collateral investigation on how students' perceptions changed after they had completed various modules in their first semester. In order to determine how the students' perceptions were affected, the questionnaire was given in the beginning of their first semester and repeated after the end of their first semester. The questionnaire is based on the SPOT-PLUS survey developed by the Directorate General for Education and Culture of the European Commission (ECEC) in 2004 (Latif, Bahroom & San, 2009:69). Some contents were adapted with the aim to be more relevant on our campus. Section D of the questionnaire is most relevant for this study as it measures students' perceptions about technology and traditional classrooms. The other sections will only be discussed briefly.

For the statistical analysis, variables were created for each section. For the first questionnaire, variables were created for section A as AA1 up to AA14, where the first A indicates the first questionnaire. For section B, variables AB1 up to AB4 were created etc. For the second questionnaire, variables BA1 up to BA14 were created etc. For data capturing purposes, options were indicated by a 1,2,3,4 or 5 depending on the number of options that were available. If, for example, the student chose "mostly agree" in section A (see table 3.2), a 2 indicates that option 2 was selected. The questionnaire consisted of five sections, each consisting of their own set of possible responses which are shown in table 3.2.

Table 3.2: Questionnaire layout

Section	Description/Aim	Possible choices for section	Number of questions
A	Stress levels	1. "totally agree", 2. "mostly agree", 3. "mostly disagree", 4. "totally disagree" or 5. "I do not know"	14
B	Computer literacy	1. "Can do this myself", 2. "I would need some help" and 3. "I don't think that I can do this on my own"	4
C	Involvement in advanced classroom technology integration	1. "Several times", 2. "Once" or 3. "Never"	4
D	Perceptions of technology usage in class and student teaching preferences	1. "I totally agree", 2. "I mostly agree", 3. "I mostly disagree", 4. "I totally disagree" and 5. "I do not know"	18
E	Involvement in classroom technology integration	1. "Did not use", 2. "Used but did not enjoy at all", 3. "Enjoyed the technology", 4. "Enjoyed and contributed to learning" and 5. "Want to use it again"	14

In the first section of the SPOT-PLUS survey, demographic profiles of students were collected (Gender, Age, marital status and qualifications). Section A was adapted to fit students on our campus. The gender and age were also collected; however, marital status and qualifications were omitted because the questionnaire was intended for first year extended students.

Additional statements were added on whether they agree or disagree with statements that relate to their perceptions on their own studies and stress levels.

Section B was used as is, with no adaptions. This section enquires about a student's ability to use four standard software applications (word processor, e-mail software, presentation software and a digital library) to complete certain tasks such as creating a CV (word processor), sending a document (e-mail), creating a slideshow (presentation software) and searching for an article (on-line bibliographical database).

Section C was used as is with no adaptions except changing "academic support via e-mail" to "academic support from lecturer via e-mail". It measures a student's experience with different ICT tools (interactive websites, video conferencing, virtual learning environment or received support from a lecturer via e-mail). .

Section D in the original questionnaire consists of 20 questions that measure students' perceptions about the use of technology in the classroom. In the original questionnaire there are two factors or groups: "positive perception of the use of technology in the classroom" and "positive perception about traditional teaching methods". The two factors/ groups remained the same; in short, they are called *traditional*- and *technology* based classrooms. The groupings of the questions are provided n table 3.3. Minor adaptions were made to make questions relevant to students on our campus. This section of the questionnaire is the most relevant part for this study.

Table 3.3: Section D Question grouping

Items in section D	**Technology or traditional**
1. I like being taught in a classroom setting, the traditional way.(Lecturer in front with slideshows)	Traditional

Items in section D	Technology or traditional
2. I think audio and video can improve my learning	Technology
3. I like using new technology	Technology
4. I think technology can improve teaching and learning in the IT class	Technology
5. Using technology can be time consuming	Traditional
6. I prefer to study with traditional educational methods	Traditional
7. I prefer reading from a printed text	Traditional
8. Cell phones can contribute to the learning process. E.g. access eFundi	Technology
9. Computer-based teaching/learning is lacking in 'human'-interaction, since there is no face to face contact	Traditional
10. I prefer to learn on my own	Filler
11. I would like to explore learning with different technologies	Technology
12. If studying with a computer becomes too complex, I would like to switch back to traditional methods	Traditional
13. I find change hard	Traditional
14. I like to learn in small groups	Filler
15. I would like to study with computer based technology even if it is complicated	Technology

Items in section D	Technology or traditional
16. I like it when lecturers make use of something new in the IT classroom instead of the same traditional methods	Technology
17. I like being taught a traditional fashion	Traditional
18. If a task becomes too difficult I am likely to drop it	Traditional

Finally, Section E consists of 14 listed technologies where the student had to indicate whether he/she "Did not use", "Used but did not enjoy at all", "Enjoyed the technology", "Enjoyed and contributed to learning" and "Want to use it again". Some of the listed technologies were changed to fit our campus (technologies used on our campus).

3.3.2 Data obtained from eFundi™

The functionalities of eFundi™ are given in table 2.2 (see section 2.4.3.1). The *resources* and *statistics* functionalities were used for the data analysis for this study.

3.3.2.1 Resources functionality

The resources functionality is used to make various course resources available. Table 3.4 shows all the resources available to students on eFundi™ grouped into the main focus areas of the module namely *Theory*, *Algorithms*, *Conversions and Other*. The *Other* category contains all the resources that are not related to subject content, for example schedules, marks, site pictures etc.

Table 3.4: Course resources available to students on eFundi™

Main focus area of subject	Resources available to students
Theory	Chap1_Summary.pdf
	Chap1_Summary.pdf
	Chapter_3___4_THEORY.pdf
	semester test 1 examples.pdf
	Test 5 Possible Theory Questions.pdf
	Test 1 memo.pdf
	Test 5 memo.pdf
	Chap2_Summary.zip
Conversions	Chapter+3+convertions.pdf
	1 number systems intro.zip
	8bit two compliment to decimal.zip
	8bit unsigned rep to decimal.zip
	binary to decimal.zip
	binary to hexa.zip
	binary to octal.zip
	binary to sci notation.zip
	dec to 8bit two compliment rep.zip
	dec to 8bit unsigned rep.zip
	dec to Sci Notation.zip
	dec to scientific notation negative.zip
	decimal to binary.zip
	decimal to hexa.zip
	hexa to octal.zip
	octal to hexa.zip
	sci notation to decimal positive.zip
	Test 1 memo.pdf
	Test 2 memo.pdf
	Scope 2011.pdf
	Chapter 2 Conversions A Test Examples.pdf
	Chapter 3 Conversions B.doc

Main focus area of subject	Resources available to students
Algorithms	IF _ WHILE statement algorithm examples.pdf
	Chapter 5 Part 1.pdf
	Test 3 memo.pdf
	Test 4 memo.pdf
	IF _ WHILE statement algorithm examples.pdf
	REPEAT _ FOR _ ARRAY _ WHILE _ IF algorithm answers.pdf
	REPEAT _ FOR _ ARRAY _ WHILE _ IF algorithm questions.docx
Other	Schedule.xlsx
	Schedule.xlsx
	schedule-1.JPG
	schedule.jpg
	Final Module Mark.xls
	Marks T1_T4.xls
	Punte_20111023_Participation Marks.xls
	Punte_20111113_Module Mark.xls
	Marks T01-T02.xls
	Assignment 2.jpg
	Capture.PNG
	Capture.PNG
	home.png
	efundi toets.png
	efundi toets.png

3.3.2.2 Statistics functionality

The statistics functionality allows the instructor of the site to create various reports containing usage statistics on eFundi™. Figure 3.3 shows an example of creating a report using the statistics functionality in eFundi™.

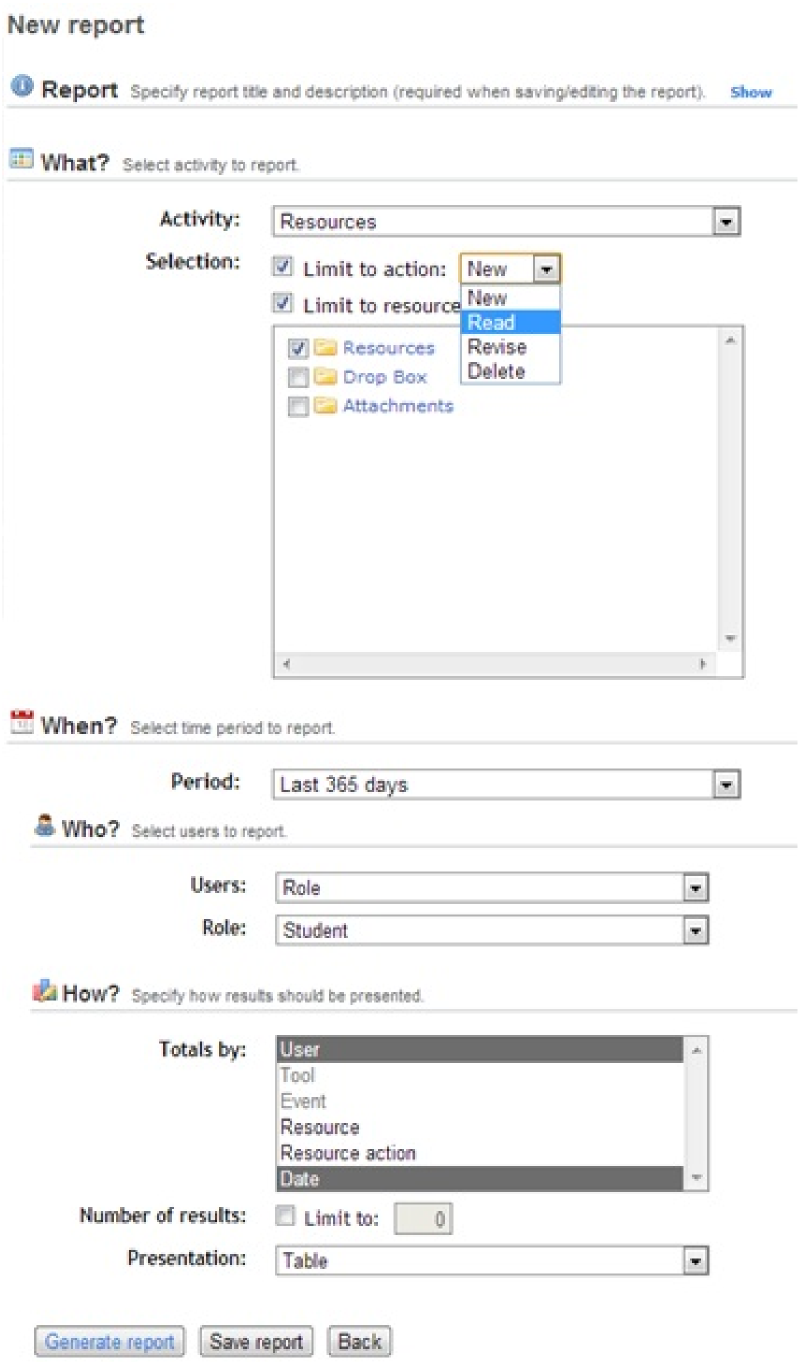

Figure 3.3: Creating reports using statistics functionality in eFundi^{TM}

There are various options when creating a report. The different options will be discussed below:

- Activity: The three activities to choose from namely Visits (site visits), Events (Announcements, Assignments, Assignments, Tests and surveys, Gradebook, Messages, Polls etc.), Resources (Resources, Dropbox and Attachments- attachments on assignments and announcements).

- Selection:
  - Limit to action: Statistics can be limited to a certain action (New, Revise, Read or Delete). Students can only create new, revise and/or delete resources in a eFundi™ areas such as Dropbox, where documents can be added, new versions uploaded or deleted. The Read action is normally associated with the Resources area as students are not allowed to change contents, but only to download or read resources.
  - Limit to resource: The three available resources on eFundi™ to choose from are Resources, Dropbox and Attachments (attachments on assignments and announcements).
- When: The options available are All, the last 7 days, the last 30 days, the last 365 days or Custom.
- Who:
  - Users: A choice of All (all registered users of the site including the instructors and Teaching assistants), Role (Student, instructor and Teaching assistant), Custom (choose users of a list of all registered users) and none can be made.

- How: Choose options of how data should be presented e.g. if totals should be per user, tool, event, resource, resource action or date.
- Presentation: Choose whether data should be represented in a table, in a chart or in a table and chart.

The statistics captured include the data of which resources have been used by whom and how many times each item was used. This statistical data together with the students' exam marks were used to investigate relationships between the students' use of learning resources and their performance.

3.3.3 Student marks

As discussed in section 3.3.2, various resources were uploaded for student use including videos, old tests, old examinations, summaries of chapters and schedules. All resources were grouped into four categories namely theory, conversions, algorithms and other (mainly schedules and site pictures). The students' examination mark and module mark were included for the data analysis for the purpose of identifying possible relationships between the usage of certain resources and the performance of students.

3.3.3.1 Exam marks

The exam paper had three main sections namely theory, conversions and algorithms and corresponds with the groupings of resources for data analysis on eFundi™ (see table 3.4 & 3.5). The examination was a written exam with duration of 3 hours.

Table 3.5: Data sections on eFundi™ and examination

eFundi™ resource categories	Description of resources on eFundi™	Official exam paper sections
Theory	Chapter summaries, old tests	Theory questions
Conversions	Videos, exercises and solutions	Conversion questions
Algorithms	Videos, exercises and solutions, old tests, summaries	Algorithm questions
Other	Schedule, participation marks etc.	None

3.3.3.2 Module marks

The students had to write four tests in the semester, of which the best three counted towards their participation mark. A fifth test was also scheduled to make provision for students who could not write one of the four tests due to unforeseen circumstances. The participation mark contributes 50 per cent towards a student's module mark. The other 50 per cent is made up of the students' exam mark (See figure 3.4).

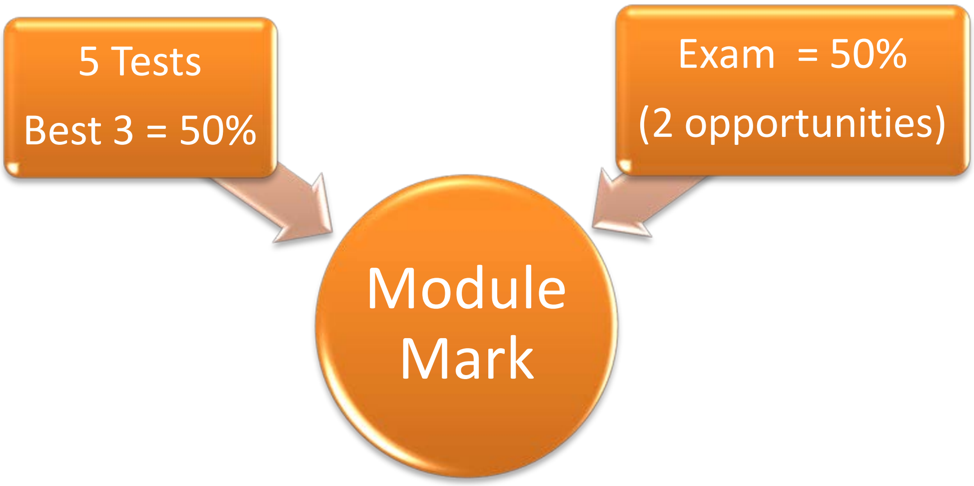

Figure 3.4: Module mark breakdown.

3.4 ETHICAL CONSIDERATIONS

Following a discussion with the research director of the campus and the head of the ethics committee about the nature of the study, the following basic guidelines were followed in the data collection and analysis process:

- Students were informed of the study.
- Students gave the necessary consent to participate in the study anonymously by completing the questionnaire.
- All students were treated the same.
- Students' identities were protected.
- The data collection process for the current study did not interfere with the course offering in any way.

3.5 DATA ANALYSIS

The data collected from the four sources (questionnaire, eFundi™, student exam marks and module marks) which are used for this study were processed and analysed with the help of the Statistical Consultation Services of the NWU (see Annexure B).

3.5.1 Questionnaire

3.5.1.1 Validity and reliability

There are various measures of validity; some commonly used measures are content -, face – and construct validity (Del Greco, Walop, McCarthy, 1987:699).

- Content validity refers to whether the content of the questionnaire adequately addresses the content domain.
- Face validity refers to the appearance of the questionnaire.
- Construct validity refers to how well a questionnaire conforms to existing ideas and inferences about a certain construct.

Because the questionnaire is based on a well-validated questionnaire with only a small amount of localisation, we have not performed additional validation for this study.

In terms of reliability, Cronbach's alpha was used to determine the reliability of the questionnaire. Cronbach's alpha is a technique used to test reliability that provides an estimate of the consistency – and thus reliability of measured data (Gliem & Gliem, 2003:84).

The alpha coefficient ranges in value between 0 and 1. It is used to describe the reliability of questionnaires that contain questions with two possible answers or rating scale questionnaires (Reynaldo & Santos, 1999). Nunnally (1978:245) suggests that a value of 0.7 or higher for Cronbach's alpha indicates acceptable reliability.

3.5.1.2 t-test

A paired sample t-test makes use of two observed data sets. Each value in the first data set is paired with a value in the second data set and is therefore said to be dependant. The paired t-test is performed in order to establish whether there is a statistically significant difference between the two sample means (Wilkerson, 2008:2).

The t-test was performed in this study in order to determine whether the students' perceptions have changed from the first – to the second questionnaire.

3.5.1.3 Correlations

Pearson's coefficient of correlation is defined as a measure of linear relationship between two variables, either positive or negative. A positive slope in a scatter diagram indicates a positive value for r, and a negative slope in turn indicates a negative correlation between the variables. The value of r ranges between –1 and 1 where 1 indicates a perfect linear relationship (Steyn, Smit, Du Toit & Strasheim, 2000:177; Swanepoel, Swanepoel, van Graan, Allison & Santana, 2011:112-113).

Microsoft Excel was used to summarise and calculate Pearson's correlation coefficients between the students' responses in section D of the questionnaire, students' exam and module marks and students use of resources posted on eFundi^{TM}.

3.5.2 eFundi^{TM}

3.5.2.1 Correlations

Microsoft Excel was utilized to summarise the statistics derived from eFundi^{TM}. SPSS was then used to measure correlations between the different resource categories' usage and the exam marks obtained for each section. Pearson's correlation coefficient was used with a significance level of 0.05 and 0.01.

3.5.2.2 Regression Models

SPSS was used to run simple – and multiple regression models in an attempt to identify predictors of student performance. Simple regression models make use of data sets containing two variable observations eg. $(x_1,y_1),..,(x_n,y_n)$. If a change of the values of *y* is explained by change of the values of *x*, *x* is known to be the independent variable and *y* the dependent variable (Swanepoel *et al*., 2011:103). Regression describes the linear relationships between variables and makes predictions regarding the variables (Swanepoel *et al.*, 2011:115). Multiple regression models contain more than one independent variable *x* (Swanepoel *et al*., 2011:297).

3.6 CONCLUSION

In this chapter the target population and sample were highlighted, as well as the research design. The data collection methods were discussed in detail and the data analysis was outlined.

In the next chapter the research results are discussed in detail.

CHAPTER 4
RESULTS AND FINDINGS

4.1 INTRODUCTION

This chapter contains results obtained from the investigation, that is, the evaluation of completed questionnaire responses and statistical data derived from eFundi^{TM}. In section 4.2 results will be presented and a discussion will follow in section 4.3. The chapter concludes with a summary in section 4.4.

4.2 RESULTS

As discussed in section 3.4, data were collected from a general questionnaire that tested student perceptions of technology, eFundi^{TM} statistics, students' exam and module marks. The results are discussed below:

4.2.1 Questionnaire

Due to various circumstances, only 24 students completed the questionnaire both before and after their first semester. All sections of the questionnaire were discussed in section 3.4.1. The reliability of the questionnaire was determined through the use of Cronbach's alpha which will be discussed in the next section. In order to determine whether there was any statistically significant difference between the first and second questionnaire, that is, whether students' perceptions had changed, the paired t-test with a significance level of 0.05 was performed and will be discussed in section 4.2.1.2. Pearson's correlation coefficient was used to determine whether there are any statistically significant correlations between students' perceptions about technology integration in class (section D of questionnaire), the use of resources posted on eFundi^{TM} and students' exam and module marks.

4.2.1.1 Validity and reliability

There are various types of validity which can be measured for questionnaires as discussed in section 3.5.1.1. Because an existing questionnaire with minor changes was used, it was assumed that the validity of the existing questionnaire is in order.

Cronbach's alpha values were used to determine reliability of the questionnaire (see table 4.1). The main focus of the questionnaire was section D, which was divided into two factors or groups: "positive perception of the use of technology in the classroom" and "positive perception about traditional teaching methods". The aim was to see whether the students' perceptions changed before and after the semester. The alpha coefficient for section D (technology) is .579 before - and .673 after the semester. The alpha coefficient for section D (traditional) is .614 before - and .601 after the semester. Nunnally (1978:245) suggests a value of 0.7 or higher for the alpha coefficient. George and Mallery (2003:231) provides the following scales: if the alpha coefficient is >.9 Excellent, >.8 Good, >.7 Acceptable, >.6 Questionable, >.5 Poor and <.5 Unacceptable. According to George and Mallery (2003:231) the above mentioned alpha coefficients for the technology and traditional groups are questionable. A low value of alpha can be also be explained by items/ constructs that are not really related or a low number of questions (Tavakol & Dennick, 2011:54), which is more likely to be the problem in this questionnaire, given its derivation from a well-established baseline questionnaire. Deletion of any of the items did not improve the reliability of the questionnaire greatly. Fortunately, the questionnaires were not critical to our main investigation; the results obtained will therefore reported even though we realize that their reliability is somewhat limited.

Table 4.1: Cronbach's alpha values for questionnaire

Section	Before	After
A	.473	.574
B	.626	.743
C	.368	-.377
D (Technology)	.579	.673
D (Traditional)	.614	.601
E	.707	.721

4.2.1.2 Paired sample t-test

As discussed in section 3.4.1, section D of the questionnaire is most relevant to the current study. It consists of two groups of questions: "positive perception of the use of technology in the classroom" and "positive perception about traditional teaching methods". The grouping of the questions was provided in table 3.3. Table 4.2 shows the t- values and p- values for the first and second questionnaire for this section.

Table 4.2: Paired t-test for Section D

Variable		T	Df	Sig. (2-tailed)
Pair 5	AD-Tech – BD-Tech	-1.964	23	.062
Pair 6	AD-Trad – BD-Trad	-.736	23	.469

Table 4.2 shows that there is no statistically significant difference between the first – and second questionnaire for groups, technology - and traditional classrooms with $t(23) = -1.964$, $p = 0.062$, $\alpha = 0.05$ for technology classrooms and $t(23) = -.736$, $p = 0.469$, $\alpha = 0.05$ for traditional classrooms.

Although the student perceptions, as reflected in Section D, did not change, other sections of the questionnaire did reflect significant changes during the semester. For example, Table 4.3 below shows the results of the paired t-test conducted on the responses to section B.

Table 4.3: Paired t-test on section B

Variable		T	Df	Sig. (2-tailed)
Pair 2	AB_Tot - BB_Tot	2.532	23	.019

The paired sample t-test shown in table 4.3 shows that there is a statistically significant difference between the perceptions of students regarding computer skills in the first and second questionnaire, $t(23) = 2.532$, $p = 0.19$, $\alpha = 0.05$. On closer analysis, the change is mostly due to students' improved abilities with online databases and the creation of presentations: Figures 4.1 and 4.2 show that students became significantly more confident in these tasks during the course of the semester.

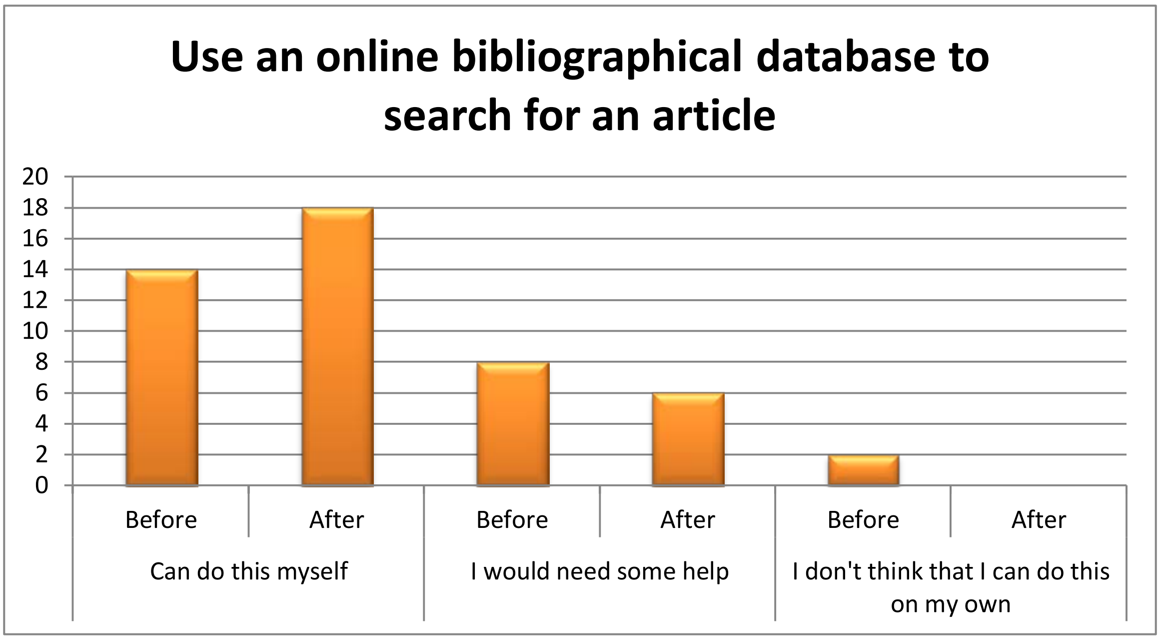

Figure 4.1: Students' ability to search for an article using an online database

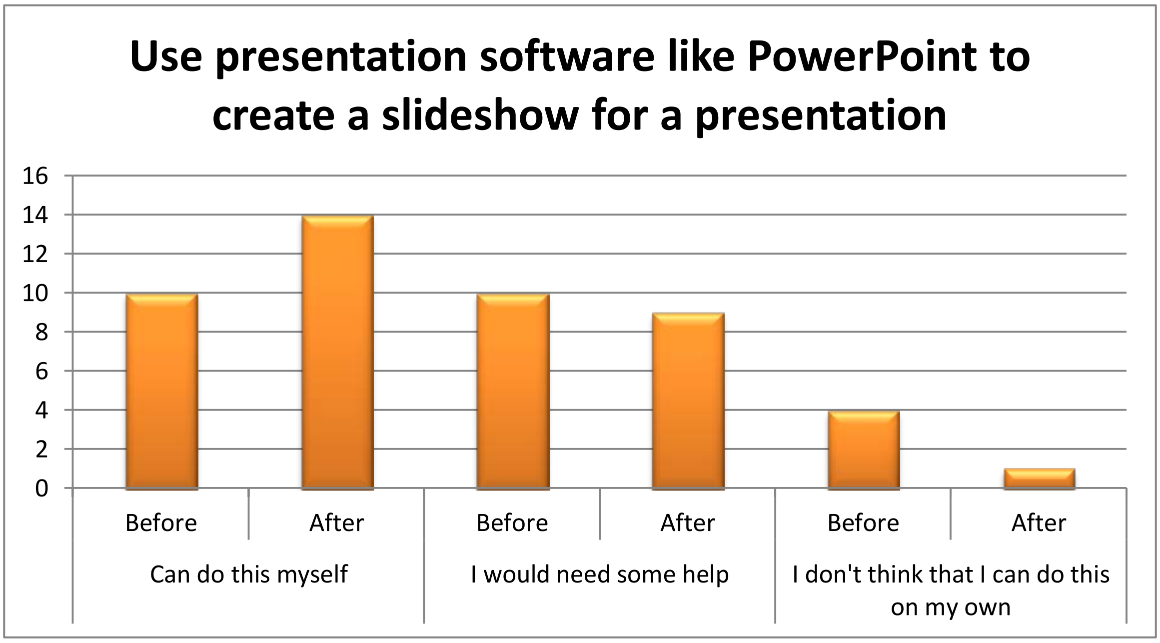

Figure 4.2: Students' ability to create a PowerPoint slideshow

4.2.1.3 Correlations

As discussed in the previous section, section D of the questionnaire aimed to measure students' perceptions about using traditional and technological methods in class. Microsoft Excel was utilized to calculate Pearson's correlation coefficient between students' responses in section D, students' use of resources posted on eFundi^{TM} and students' exam and module marks.

No statistically significant correlations at the p=0,05 level were recorded.

4.2.2 eFundi^{TM}

As discussed in section 3.2.1. The *resources* and *statistics* functionalities were used for the data analysis for this study. The students received various module resources on eFundi^{TM}'s resources functionality and were divided into four categories for data analysis purposes (see table 3.5). The correlations and regression models are discussed in the sections that follow.

4.2.2.1 Correlations

In order to determine the relationship between students' performance and resources used on eFundi^{TM}, use was made of Pearson's correlation coefficient. The results in table 4.4 show the correlation between student marks for the module, marks in each section of the exam and the number of times the different categories of resources were opened.

Table 4.4: Relationship between different sections of exam marks and different resources used

		Total res. used	Total res. usage Theory	Total res. usage Conv.	Total res. usage Alg.	Total res. used Other
Exam theory Mark	Pearson Corre-lation	0.193	.226	0.235	**0.331***	**.**039
	Sig. (1-tailed)	0.123	0.086	0.078	0.021	0.409
Exam conv. mark	Pearson Corre-lation	**.278***	0.26	**.302***	.090	0.135
	Sig. (1-tailed)	0.046	0.057	0.033	0.295	0.209
Exam alg. Mark	Pearson Corre-lation	0.091	**.**126	0.147	0.196	.050
	Sig. (1-tailed)	0.293	0.225	0.189	0.119	0.382

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

Table 4.5 shows correlations between a student's exam mark, module mark and different resources used.

Table 4.5: Relationship between a student's marks and different resources

		Total res. used	Total res. usage Theory	Total res. usage Conv.	Total res. usage Alg.	Total res. used Other
Exam Mark	Pearson Correlation	.241	**.287***	**.283***	**.**244	.098
	Sig. (1-tailed)	0.073	0.04	0.043	0.07	0.279
Module Mark	Pearson Correlation	**.**214	.180	.211	.182	.063
	Sig. (1-tailed)	0.099	0.14	0.102	0.137	0.354

**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).

The statistically significant correlations that were in the data (see table 4.4 & 4.5) are listed below. All correlations are significant at the 5 per cent significance level, which had been determined as the threshold for significance before the start of the study, and trivial correlations have been omitted.

1. A correlation of .302 between a student's exam mark for conversions and the number of resources used on conversions.

2. A correlation of .287 between a student's exam mark and the total number of theory resources used

3. A correlation of .283 between the student's exam mark and the total number of conversion resources used.

4. A correlation of .278 between the total numbers of resource used on eFundi^{TM} and a student's conversion mark in the exam.

These statistical significant correlations were then used to run stepwise and multiple regression models in order to determine whether there are any predictors of student performance present in the data. This is discussed in the next section.

4.2.2.2 Regression Analysis

Stepwise and multiple regression models were run in SPSS in order to determine whether any predictors of student performance are present in the data according to Pearson's correlation coefficients provided in table 4.4 and table 4.5.

Firstly a stepwise regression model was run in SPSS. The students' exam mark for theory was chosen as the dependent variable as derived from table 4.4, to see whether total resources used for theory, conversions, algorithms and other predicts a students' performance in the theory part of the exam. In SPSS, students' exam marks for theory (dependant variable) was regressed by the total number of algorithm resources used (independent variable) and are shown in table 4.6. The variables that are excluded in this model by SPSS include the total resources used for theory, conversions and other. The independent variable (total algorithm resources used) added statistically significantly to the prediction, p <.05. The model explains 8.5 per cent (see adjusted R-squared) of the variance of students' theory marks in the exam.

Table 4.6: Stepwise regression analysis of students' theory marks on total algorithm resources used

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	65.947	3.926		16.799	.000
	Tot_Algorithms	.385	.183	.331	2.104	.042

$F(1,36) = 4.428$, $p = 0.042$, Adjusted R-Squared = .085 (8.5%)

The second stepwise regression model that was run used the students' mark for conversions in the exam as the dependant variable (see table 4.5), to see whether total resources used for theory, conversions, algorithms and other (independent variables) predicts a students' performance in the conversion part of the exam. All the independent variables were excluded by SPSS, thus no variables added statistically significantly to the prediction.

A multiple regression model was then set up (see table 4.7) in SPSS with students' exam marks (the total for theory, algorithms and conversions) as the dependant variable regressed by the total number of algorithm -, theory –, conversion – and other resources used (independent variables). None of the independent variables added statistically significantly to the prediction, p >.05 for all variables. The model explains 1.9 per cent (see adjusted R-squared) of the variance of students' exam marks.

Table 4.7: Multiple regression analysis of students' exam mark on total resources used for algorithms, theory, conversions and other.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	**(Constant)**	69.200	4.481		15.442	.000
	Tot_Theory	.211	.337	.153	.626	.536
	Tot_Conversions	.375	.456	.222	.823	.417
	Tot_Algorithms	.185	.256	.171	.721	.476
	Tot_Other	-.177	.174	-.241	-1.019	.316

$F(4,33) = 1.177$, $p = 0.339$, Adjusted R-Squared = .019 (1.9%)

4.3 DISCUSSION

In section 4.2.1.1, Cronbach's alpha coefficient is provided for all sections of the questionnaire. The alpha coefficient for the two groups (Technology and Traditional) in section D is questionable (George & Mallery, 2003:231) and a possible reason for a low value of alpha can be because items/ constructs are not really related or there can be a low number of questions which is more likely to be the problem in this questionnaire (Tavakol & Dennick, 2011:54). .

In section 4.2.1.2, the questionnaire's results were summarized. The paired t-test was performed and statistically significant differences were not recorded for section D, which was the most pertinent to our study. Although students' perceptions did not change statistically significantly after the first semester, students had a generally positive perception about technology use in the classroom from the start of the semester. In figure 4.3 the possible responses ("I mostly agree", "I totally agree", "I mostly disagree", "I totally disagree", "I don't know") for traditional groups were grouped into two categories namely, positive ("I mostly agree", "I totally agree") and negative ("I mostly disagree", "I totally disagree", "I don't know"). Missing values were also grouped into the negative category. Student's perceptions stayed more or less the same before and after with 52 per cent of responses positive towards traditional teaching methods before and 50 per cent afterwards.

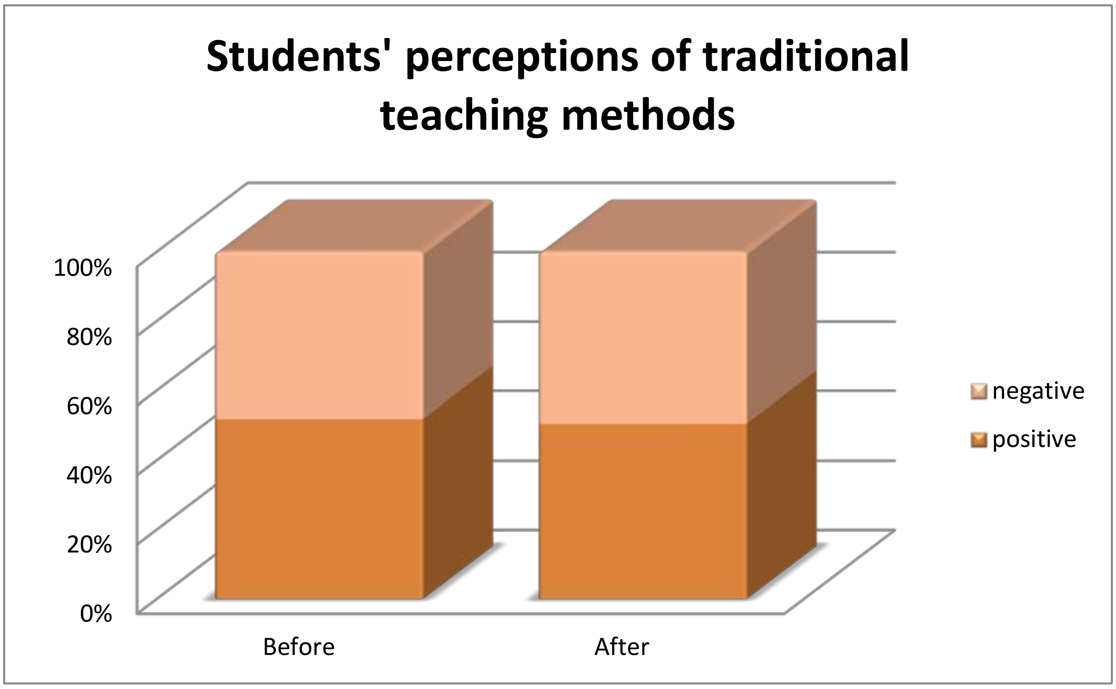

Figure 4.3: Students' perceptions of traditional teaching methods

Figure 4.4 shows the students' responses towards technology use in the classroom. The students' perceptions stayed the same towards technology use in the classroom with 90 per cent of students' responses positive towards technology use in the classroom before and 92 per cent afterwards.

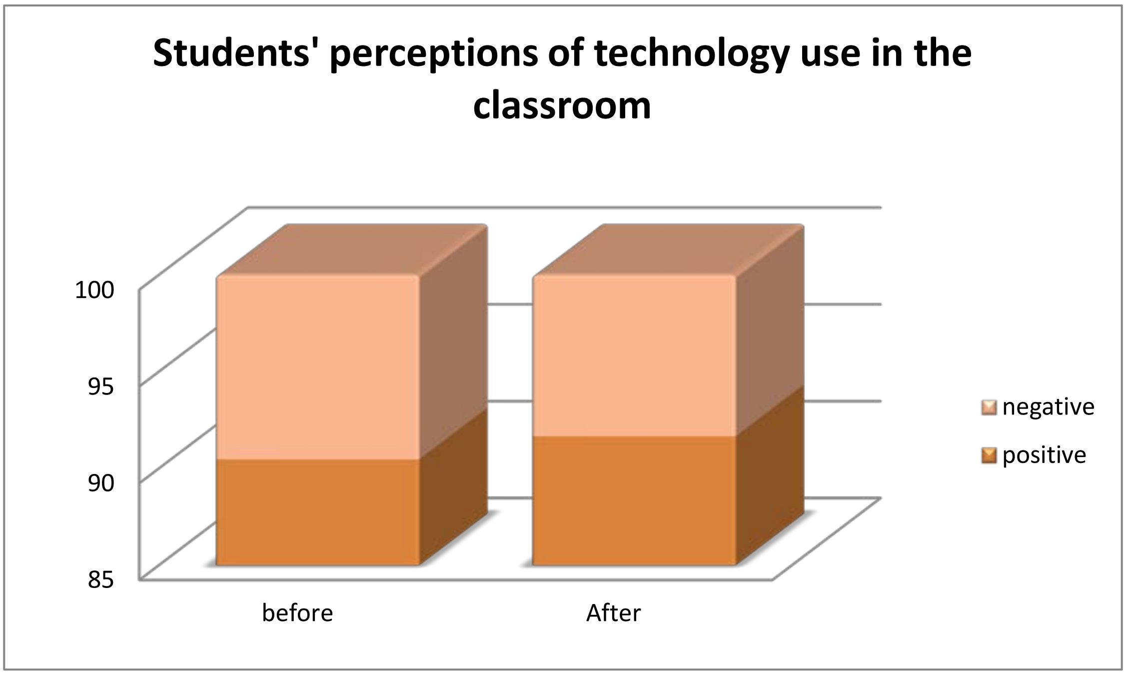

Figure 4.4: Students' perceptions of technology use in the classroom.

Various resources were available to students. Pearson's correlation coefficient was used to determine whether any linear relationships exist between the usage of different resources, students' marks for the relevant section in the exam and module marks. These correlations are shown in Table 4.4 and Table 4.5. Statistically significant correlations were observed in four cases; these suggest that students did obtain some measurable benefit from using the eFundi^{TM} resources. These correlations are all fairly small, but this is not surprising given all the other factors, besides resource usage, that determine success on the examination.

The correlations were used to set up regression analysis in SPSS. The stepwise and multiple regression analysis were performed and the total number of algorithm resources used added statistically significantly to the prediction of a student's exam mark obtained for theory.

4.4 CONCLUSION

In this chapter the research results were presented. Students' perceptions' did not change from the start to the end of the semester about technology - and traditional based classrooms. However, they hold positive perceptions about technology use in the classroom (90% before and 92% after). On average 51 per cent of students responded positively towards traditional teaching methods (50% before and 52% after).

Students were introduced to eFundi™ where various course resources were uploaded for their use. The usage of some resources has been shown to hold small but statistically significant linear relationships with students' performance. Interestingly, the advantages of resource usage are not limited to the particular topic of the resources used. For example, whereas usage of *Conversion* resources correlated with a student's mark obtained for the *Conversion* section in the exam (as expected), we also found a significant correlation between usage of the resources related to *Algorithms* and the *Theory* section of the examination. Each of the individual resources correlated positively with the overall mark obtained by a student for the exam, although the correlation with the *Algorithms* resource fell just short of statistical significance. The correlation between students' performance, resource usage and students' perceptions proved to hold no significance; hence, these perceptions do not seem like a major factor in this student group's academic performance.

In order to identify predictors of students' performance, the above mentioned correlations were used to set up regression analysis. The only statistically significant predictor was the total number of algorithm resources used on a student's performance in the theory part of the exam.

In the next chapter the research is concluded and recommendations are given.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

The research conducted is concluded in this chapter. A summary of the research is given in section 5.2. In section 5.3 the research contributions are summarized. The limitations and future research opportunities are discussed in section 5.4. This chapter concludes in section 5.5.

5.2 SUMMARY

The primary objective of this study was to identify predictors of student performance within their use of Education Technology, more specifically, a LMS used at the NWU Vaal Triangle campus.. In order to reach the primary objective of the study, the first theoretical objective was to identify factors that influence IT student performance. A literature study was completed in Chapter 2 and various predictors of success were identified. Some of the most prominent predictors of success in the performance of IT students revealed in the literature include mental models, learning styles, mathematical ability, prior programming experience and gender in conjunction with other predictors.

The second theoretical objective was to identify various Education Technologies that can help overcome some of the factors that influence student performance. There is a wide variety of education tools available to overcome some of the problems associated with the predictors. Some of these education technologies include E-learning, graphical programming environments (Scratch, Alice) and serious games (see section 2.4.3).

In chapter 1, empirical objectives were formulated in accordance with the primary objective, the first one being to determine the correlation between the usage of resources provided on a LMS and student performance. The second empirical objective was to determine whether the use of certain resources provided on a LMS predict student performance. In this study, eFundi™, a

LMS used at the NWU Vaal Triangle campus was used to provide students with various course resources and the usage thereof was tracked using one of the eFundi™ functionalities called *statistics*. The predictors of IT students' success are potentially related to their perceptions and the ways in which the technology is used. As a collateral part of the study, a questionnaire was given to students before and after their first semester to determine whether students' perception about technology integration in the classroom had changed after they had encountered various technologies in their modules. Statistical analyses were performed on all the data gathered from the resource usage on eFundi™, students' exam and module marks and questionnaire responses. The analysis revealed that there are certain measurable advantages to using these resources which will be discussed next in relation to the objectives of the study.

In terms of the first empirical objective mentioned, significant correlations were found between learning activities (resource usage) and student performance (see section 4.2.2). It is clear that the advantages of using particular resources are not necessarily dependent on the particular topic of the resources used. For example, a correlation between the usage of *Conversion* resources and a student's mark obtained for the *Conversion* section in the exam was found. A significant correlation between usage of the resources related to *Algorithms* and the *Theory* section of the examination was also found. The usage of each of the individual resources had a positive correlation with the overall mark obtained by a student for the exam. The correlation with the *Algorithms* resource and the exam mark obtained was also positive but fell just short of statistical significance.

In order to address the second empirical objective – to determine whether the use of certain resources provided on a LMS predict student performance, stepwise and multiple regression models were run in SPSS based on the high correlations found mentioned above. The only statistically significant predictor identified in the regression analysis was the total number of algorithm resources used on a student's performance in the theory part of the exam.

The questionnaire was issued as a collateral part of the study a) to investigate whether students' perceptions have changed about technology integration in the classroom and b) to see whether there are any statistically significant correlations between students' perceptions about traditional and technological methods of teaching (section D of questionnaire), students' use of eFundi^{TM} resources and students' exam and module marks. The paired t-test showed no statistically different change in the students' perceptions about technological and traditional teaching methods. Although their perceptions did not change significantly, their perceptions were overall positive towards technology use in the classroom. The correlation between students' performance, resource usage and students' perceptions proved to hold no significance.

In conclusion, the research question of the study was: How can IT students' use of resources provided by a LMS serve as predictors of their performance in IT-modules at the Vaal Triangle Campus of the North-West University? According to the regression analysis results, the general usage of resources on eFundi^{TM} in this study does not predict a student's performance in that module; however the use of algorithm resources is a predictor of a student's performance in the theory part of the exam. As mentioned earlier, it is clear that the advantages of using particular resources are not necessarily dependent on the particular topic of the resources used. This finding could probably be investigated further in future studies. In completion of the research, understanding was gained with regards to predictors of Education Technology's effects on IT students' performance. It is evident in this research that students' perceptions of technology use in the classroom are very positive and that the usage of Education Technology influences student performance. Although the students possess an overall positive perception about technology use in the classroom, it is not related in any straightforward way to students' resource usage or performance during the semester.

The research results made certain contributions to the IT field which will be discussed in section 5.3

5.3 CONTRIBUTIONS

These following contributions to the IT field were made:

- The correlation between Education Technology and student performance was determined in the current context.
- The usage of certain electronic resources was identified as a predictor of students' performance.
- A greater understanding was formed on how students feel about using technology to learn IT.

These results confirm that there is potential in using Education Technology in teaching the BSc. IT curricula and have implications for the development of new curriculum and study material for this campus. Further research is suggested in looking at the inclusion of more Education Technology to form part of BSc. IT curricula. Limitations and future research are discussed in the next section.

5.4 LIMITATIONS AND FUTURE RESEARCH

A limitation for this study is that the findings presented in this research cannot be generalized to the whole BSc. IT group at the Vaal Triangle campus of the North-West University in South Africa. The reason for this is because only first-year extended BSc. IT students were included on this campus. Similarly, the study cannot be generalized to other universities in South Africa. The sample size of the study was small and for that reason the study had limitations in the empirical portion of the study that accompanies small sample sizes. The empirical portion of this study mainly focused on the usage of content-related electronic resources (Education Technology) as a predictor of student performance. A limitation of the Statistics functionality of eFundi^{TM} is that the statistics recorded are limited to Read, Revise or Deletion of a resource (see section 3.3.2.2). It is possible that a student could print the document, thus only opening it once on eFundi^{TM} but actually having access to the hard copy numerous times, just as a student opening a document 20 times doesn't guarantee that the student actually read the document thoroughly.

An existing questionnaire was used to test perceptions of students about technology. It might have been more beneficial to use a questionnaire that was directly linked with the use of eFundi™ and it could have been followed up with structured interviews. More research is needed with regards to the relationship between students' perceptions of technology use, the actual use of that technology and their performance. The above mentioned limitations present many opportunities for future research including the following:

- A larger study should be performed at the North-West University, perhaps including all three campuses (Potchefstroom, Vaal Triangle and Mafikeng).
- The above mentioned study could be expanded to other universities in South Africa.
- Apart from Education Technology usage as a predictor of the performance of IT students, there are other possible variables that could influence the performance of IT students. Future studies should investigate whether the type and quality of resources made available to students via Education Technology could influence IT student performance. This could also be extended further within the IT discipline, e.g. different subject groups. Examples include programming, databases, networks and algorithms as different types of resources might have different effects on the performance of IT students.

5.5 CONCLUSION

On the whole this study has shown that students like using Education Technology and that the usage thereof can potentially influence student performance in a positive manner. Several predictors of success in IT have also been identified in the literature. These include mental models, learning styles, mathematical ability, prior programming experience and gender together with other predictors. Further research should be done to broaden knowledge about the effects of Education Technology on the performance of IT students.

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ANNEXURE A

QUESTIONNAIRE

EDUCATIONAL TECHNOLOGY QUESTIONNAIRE

Technology is a big part of our lives, and is increasingly being integrated into our study environment. This survey aims to discover how **you,** the student, feel about technology in the classroom -.

Your identity will be kept confidential.

Thank you for your valuable time!

(This survey is based on the SPOT PLUS survey.)

Please mark boxes with a cross: ☒

Name & Surname: ________________________________

Student number: __________________________________

Gender: ☐ Male ☐ Female

Age: _______

SECTION A:

Please indicate your level of agreement with the following statements by making a tick in the relevant box.

ITEMS	I totally agree	I mostly agree	I mostly disagree	I totally disagree	I do not know
1. I consider myself being relaxed most of the time	1	2	3	4	5
2. I get stressed out easily	1	2	3	4	5
3. I get distracted easily in class	1	2	3	4	5
4. I spend too little time on my studies as a result of financial constraints	1	2	3	4	5
5. My marks reflect the effort that I put into my subjects	1	2	3	4	5
6. Responsibilities tend to keep me away from my studies	1	2	3	4	5
7. I often find myself feeling stressed out about financial constraints	1	2	3	4	5
8. I consider myself a well-balanced student	1	2	3	4	5
9. I do not give enough attention to my studies	1	2	3	4	5
10. I don’t like to be faced with a challenge, it makes me feel uncomfortable	1	2	3	4	5
11. I am not motivated to study harder as a result of financial constraints	1	2	3	4	5
12. I enjoy learning new things even if it might be hard/difficult	1	2	3	4	5
13. I give up easily when I do not get something right	1	2	3	4	5
14. My financial responsibility towards my studies motivate me to perform better in my studies	1	2	3	4	5

SECTION B:

Please indicate your ability to complete the following tasks with a computer.

ITEMS	Can do this myself	I Would need some help	I don't think that I can do this on my own
1. Use a Word processor to complete a CV	1	2	3
2. Use presentation software like PowerPoint to create a slideshow for a presentation	1	2	3
3. Send a document via e-mail	1	2	3
4. Use an online bibliographical database to search for an article	1	2	3

SECTION C:

Please indicate how often, if ever, you have used or been involved in the following (mark only one option per program)

ITEMS	Several times	Once	Never
1. An interactive website in a course, such as assessment, online tasks or learning material	1	2	3
2. Video conferencing	1	2	3
3. Virtual learning environment such as Blackboard	1	2	3
4. Academic support form lecturer via e-mail	1	2	3

SECTION D:

Please indicate your level of agreement of technology usage in the classroom by making a tick in the relevant box.

ITEMS	I totally agree	I mostly agree	I mostly disagree	I totally disagree	I do not know
5. I like being taught in a classroom setting, the traditional way (lecturer in front with slideshows)	1	2	3	4	5
6. I think audio and video can improve my learning	1	2	3	4	5
7. I like using new technology	1	2	3	4	5
8. I think technology can improve teaching and learning in the IT class	1	2	3	4	5
9. Using technology can be time consuming	1	2	3	4	5
10. I prefer to study with traditional educational methods	1	2	3	4	5
11. I prefer reading from a printed text	1	2	3	4	5
12. Cell phones can contribute to the learning process. E.g. access eFundi	1	2	3	4	5
13. Computer-based teaching/learning is lacking in “human’-interaction, since there is no face-to-face contact	1	2	3	4	5
14. I prefer to learn on my own	1	2	3	4	5
15. I would like to explore learning with different technologies	1	2	3	4	5
16. If studying with a computer becomes too complex, I would like to switch back to traditional methods	1	2	3	4	5
17. I find change hard	1	2	3	4	5
18. I like to learn in small groups	1	2	3	4	5

ITEMS	I totally agree	I mostly agree	I mostly disagree	I totally disagree	I do not know
19. I would like to study with computer based technology even if it is complicated	1	2	3	4	5
20. I like it when lecturers make use of something new in the IT classroom instead of the same traditional methods	1	2	3	4	5
21. I like being taught a traditional fashion	1	2	3	4	5
22. If a task becomes too difficult I am likely to drop it	1	2	3	4	5

SECTION E:

Please indicate which of these technologies have been used in your course classes and indicate whether you felt that it contributed to the content or not.

TECHNOLOGY USED	Did not use	Used but did not enjoy at all	Enjoyed the technology	Enjoyed and contributed to learning	I want to use it again
1. Chalkboard	1	2	3	4	5
2. Whiteboard (dry and erase)	1	2	3	4	5
3. Lesson outside classroom	1	2	3	4	5
4. Transparencies	1	2	3	4	5
5. Overhead projectors	1	2	3	4	5
6. Video tape players	1	2	3	4	5
7. Video/digital cameras	1	2	3	4	5

TECHNOLOGY USED	Did not use	Used but did not enjoy at all	Enjoyed the technology	Enjoyed and contributed to learning	I want to use it again
8. E-mail communication for instruction	1	2	3	4	5
9. Electronic resources such as eFundi	1	2	3	4	5
10. Robotics	1	2	3	4	5
11. Interactive activities/lessons on a computer (no lecturer)	1	2	3	4	5
12. Clickers	1	2	3	4	5
13. Cell phones for learning activities	1	2	3	4	5
14. Online discussion forums	1	2	3	4	5

ANNEXURE B

LETTER FROM STATISTICIAN

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To whom it may concern

25th April 2013

I hereby confirm that I have done the statistical analysis for the dissertation *Predictors of education technology's effects on it students' performance* of Suné van der Linde (Student no 20083939).

The interpretation is the responsibility of the student.

Yours sincerely

Aldine Oosthuyzen
Campus IT Manager