# THE ROLE OF PRE-ENTRY ATTRIBUTES IN THE PERFORMANCE OF STUDENTS WHO ENROL FOR PROGRAMMING MODULES AT TWO HIGHER-EDUCATION INSTITUTIONS

by

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**THESIS**

Submitted in fulfilment of the full requirements for the degree

**PHILOSOPHIAE DOCTOR**

in

**ICT IN EDUCATION**

in the

FACULTY OF EDUCATION

at the

UNIVERSITY OF JOHANNESBURG

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October 2015

## DECLARATION

I, Glenda Barlow-Jones, declare that the work depicted in this thesis is original (except where citations and acknowledgements indicate otherwise). No part of this work has been, or will be, submitted in any form as part of another degree at this, or any other University.

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30 October 2015

## DECLARATION BY THE EDITOR

The editing done in this thesis was limited to language completeness and consistency, grammar, referencing check and formatting check.

Where advice was provided on structure, exemplars only were given.

Material for editing was received in an electronic format and the mark-up was done using track changes.

Candidates name: Glenda Barlow-Jones

Title of thesis: The Role of Pre-Entry Attributes in the Performance of Students Who Enrol for Programming Modules at two Higher-Education Institutions

I declare that I have edited/proofread this thesis in compliance with the above conditions as instructed when engaged by the candidate.



__________________________________ 27 October 2015

Tammy Ann Oppenheim
Editor

## DEDICATION

In memory of my baby Chad Barlow-Jones
(20 January 2004 - 21 January 2004)

A person's a person no matter how small. - Dr.Seuss

### THE DRAGONFLY

Once, in a little pond, in the muddy water under the lily pads, there lived a little water beetle in a community of water beetles. They lived a simple and comfortable life in the pond with few disturbances and interruptions. Once in a while, sadness would come to the community when one of their fellow beetles would climb the stem of a lily pad and would never be seen again. They knew when this happened; their friend was dead, gone forever. Then, one day, one little water beetle felt an irresistible urge to climb up that stem. However, he was determined that he would not leave forever. He would come back and tell his friends what he had found at the top. When he reached the top and climbed out of the water onto the surface of the lily pad, he was so tired, and the sun felt so warm, that he decided he must take a nap. As he slept, his body changed and when he woke up, he had turned into a beautiful blue-tailed dragonfly with broad wings and a slender body designed for flying. So, fly he did! And, as he soared he saw the beauty of a whole new world and a far superior way of life to what he had never known existed. Then he remembered his beetle friends and how they were thinking by now he was dead. He wanted to go back to tell them, and explain to them that he was now more alive than he had ever been before. His life had been fulfilled rather than ended. But, his new body would not go down into the water. He could not get back to tell his friends the good news. Then he understood that their time would come, when they, too, would know what he now knew. So, he raised his wings and flew off into his joyous new life!

-Author Unknown

## ACKNOWLEDGEMENTS

I would like to thank the following people for their support:

My husband Wayne, you deserve a gold medal for putting up with all my nonsense for the last six years. Anyone else would have left long ago – I'm glad you didn't. Thank you for supporting me and loving me unconditionally. I love you.

My eleven year old twins, Jemma and Paige, you finally have your "nice" Mommy back and hopefully you won't be seeing "grumpy" Mommy for a very long time.
I love you two to Pluto and back.

My supervisor Professor Duan van der Westhuizen, I think I need to buy you a case of Jack Daniels to make up for being the worst student ever. Thank you for waving your magic wand over my work and for your help, guidance, support, understanding, and above all patience. I appreciate it.

My in-laws, Des and Merle in Umtentweni, who had my children over every June holiday so that I could get on with my PhD. I am grateful for the sacrifices that you have made for me and appreciate all your help, love, and support more than you will ever know.

My sister Sharon, who is busy with her Master's degree in Education. You can do it Sis. I love you a lottle.

My Mom and Dad, Ailsa and John, and my other siblings, Gordon, Tammy and Janet – thank you for your support.

One of my best friends and colleague, Jacqui Chetty, who is also busy with her PhD and probably understands me a lot better than most people. Thank you for listening to all my ranting and raving and telling me to just get on with it when I wanted to give up (which was at least once a month). You are my BBFF. I look forward to a lot more “research adventures” with you.

Carla Coetzee at the Tshwane University of Technology, thank you for helping me with the collection of data. I know what a pain it has been and really appreciate all your efforts. Without you I truly don’t know what I would have done. I look forward to writing some more conference papers with you.

Richard Devey at Stakon, I owe you a big chocolate. Thank you for all your help with my data analysis – I’m sure that you are happy to put my files (of which there are many) to ‘bed’.

Barbara Mahosa at Social Surveys, thank you for patiently sitting with me (for 32 hours) and painstakingly helping me with my Chapter 4.

Tammy Oppenheim at the Independent Institute of Education thank you for editing my thesis.

Ronel and Lucinda at the Applied Information Systems Department at the University of Johannesburg, thank you for all the administration help you gave me and for all the cups of coffee (hugs in a mug) and chats throughout this journey. Also to two good friends of mine: Bev, I’ll be listening out for your “lee, lee, lee” at my graduation and Nola, maybe when you come and visit me now, I won’t be wearing my pyjamas.

The ladies who I walk with on a Saturday morning, Dihona, Tracey, and Loren, who have listened to me moan and complain about my PhD since I have known them. Ladies, it is finally done, we can talk about something else now.

To all my other friends and family members of whom there are too many to mention: you have all touched my life in some way or another and I am grateful for each and every one of you. There will definitely be a party after I “finally” graduate, to which you are all invited.

# ABSTRACT

Performance in computer programming modules at Higher Education Institutions has traditionally been low. Within the context of world-wide shortages of skilled programmers, it becomes imperative that greater success is achieved in HEIs. The low success rate in programming modules is ascribed to the abstract nature and content of programming courses, and the inadequacy of pre-university education to prepare students for the cognitive skills required for success in such courses. This study identifies and relates the pre-entry attributes of students at universities in Johannesburg and Pretoria, South Africa before enrolling for computer programming courses. In the quest for identifying those attributes that may have impacted on student success in the programming modules, their problem solving ability, socio-economic status, educational background, performance in school mathematics, English language proficiency, digital literacy and previous programming experience, were explored using a survey research method. The dataset comprised of four programming aptitude tests, a student profile questionnaire and Development Software 1 examination results of 379 students studying the National Diploma Business Information Technology at a Johannesburg City University* (JCU) and the National Diploma Information Technology at a Pretoria City University* (PCU). The data analysed indicates that there is a correlation between the variables problem solving, digital literacy and previous programming experience and performance in programming modules. There was no correlation found between the variables socio-economic status, educational background, Grade 12 mathematics marks and Grade 12 English marks and performance in programming modules. The research concluded that the marks achieved for school mathematics and English cannot be considered as a valid admission criterion for programming courses in the South African context and an alternate requirement should be found.

* Pseudonyms

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# BACKGROUND TO THE STUDY

## 1.1 INTRODUCTION

This study identifies and relates the pre-entry challenges that students at universities in Johannesburg and Pretoria, South Africa face when entering computer programming courses at the university level, and in particular those challenges that emanate from the school education years preceding their enrolment at university. The study attempts to determine the extent to which these students are hampered by the lack of the necessary problem-solving and other cognitive skills that are required for them to be successful in computer programming. In the quest for understanding those conditions that may impact on student success in programming modules, aspects of their problem solving ability, socio-economic status, educational background, performance in school mathematics, English language proficiency, digital literacy and previous programming experience, are explored using a survey research method. The findings of the study could be useful to higher educational institutions in two ways. Firstly, institutions may have to re-examine their entry requirements to programming courses, as previously held determinants of success in such courses may not hold true within the South African context. Secondly, the identification of inhibitors to success in such courses may provide guidelines for the development of pedagogical approaches to teaching programming courses[1] that directly address the limitations that students have to overcome.



[1] Such a pedagogical design is described in the twin study in the PhD research of J. Chetty, currently in preparation for submission, and entitled: An emerging pedagogy for teaching computer programming: Attending to the learning needs of under-prepared students in university-level courses.

The cognitive demands of programming and student background have been found internationally to be statistically significant predictors of students' success in computer programming courses. By means of a review of international literature it is postulated that these pre-entry attributes will have a positive predictive effect within the South African context as well. These pre-entry attributes are situated within a variety of theoretical constructs as shown in Figure 1.1.

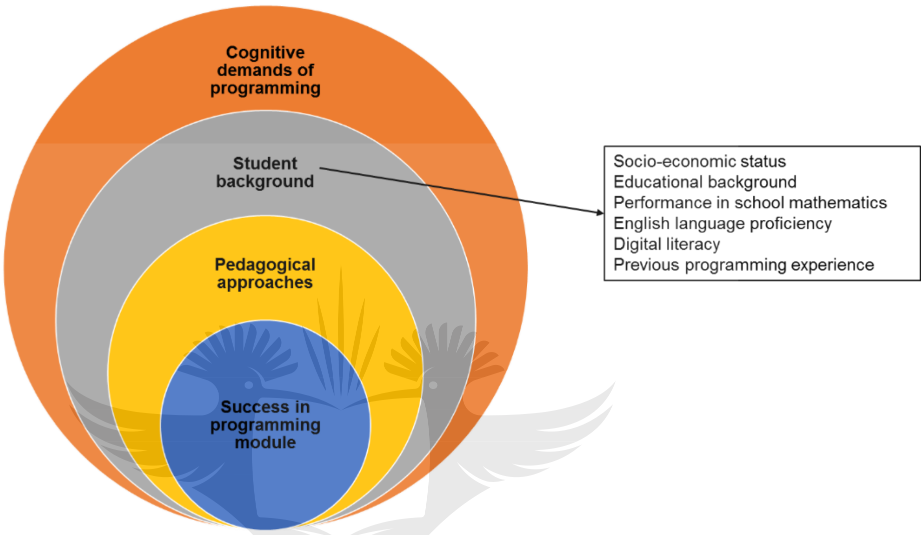


**Figure 1.1:** Pre-entry attributes thought to influence a student's success in programming modules



## 1.2 THE RATIONALE FOR THE STUDY

In subsequent paragraphs, it will be shown that performance in programming modules at Higher Education Institutions (HEIs) has traditionally been low. Within the context of world-wide shortages of skilled programmers, it becomes imperative that greater success is achieved in HEI courses.

It therefore becomes important to determine the origin of poor performance in such courses. This research particularly relates performance in programming courses with not only the traditional impediments to success (see paragraph 1.2.2), but also to particular circumstances unique to the South African context.

### 1.2.1 Poor success rate in university programming courses

Programming is one of the most required skills in the Information and Communications Technology (ICT) industry. Currently devices like smart phones, notebooks/ tablets, computers etcetera require computer programmers to develop the software to operate such devices. However, although programmers are in high demand, there is a worldwide shortage of skilled computer programmers (USNews, 2015).

It is well documented in literature (see for example Garner, 2007; Butler & Morgan, 2007; Robins, Rountree & Rountree, 2003; Corney, Teague & Thomas, 2010; Ali & Shubra, 2010; Chetty & Barlow-Jones, 2014) that computer programming modules at HEIs are characterised by low success rates. At the Queensland University of Technology (QUT) in Australia for example, it is reported that 30% or more of students fail the subject 'introductory programming' every year (Corney, Teague and Thomas, 2010). Watson and Li (2014) in an effort to provide evidence of the 'Computer Science[2] 1 (CS1) failure rate phenomenon' conducted an international study by extracting and analysing the pass rates of 161 CS1 courses that were offered in 15 different countries, across 51 institutions. A mean worldwide pass rate of 67.7% was found.



In addition to low success rates, a decline in student enrolment in Information Technology[3] (IT) related subjects at school (Ali & Shubra, 2010; Marginson, Tytler, Freeman, & Roberts, 2013; Wagstaff, 2012) is evident. According to the National

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[2]Computer science is the study of the "storage, transformation and transfer of information. The field encompasses both the theoretical study of algorithms and the practical problems involved in implementing them in terms of computer software and hardware" (Linux Information Project[a], 2006).
[3] Information Technology can be defined as the "branch of technology devoted to the study and application of data and the processing thereof. IT can also be thought of as applied computer systems, including both hardware and software, usually in the context of a business or other enterprise, and often including networking and telecommunications" (Linux Information Project[b], 2006). The term 'computer science' is usually reserved for the more theoretical, academic aspects of computing.

Centre for Education Statistics, in the United States of America (USA), CS and IT which form part of the science, technology, engineering and mathematics (STEM) fields, has seen a decrease in high school learner participation over the last 20 years (Wagstaff, 2012). Only 19% of high-school learners take a CS course in the USA, a figure that continues to drop (National Science Foundation, 2013).

The fact that CS classes are not mandatory, makes learners hesitant to take the subject because it doesn't count towards graduation requirements and is rather seen as an elective like woodwork. Electives also do not receive the same attention and resources as main subjects (National Science Foundation, 2013).

In South Africa the situation is no different. The Curriculum Assessment Policy Statement (CAPS)[4] provides for the school subject Information Technology (IT) (Department of Basic Education[b], 2011:10) in Information Technology a learner will:

- use appropriate techniques and procedures to plan solutions and devise algorithms to solve problems using suitable techniques and tools;
- understand and use appropriate communication technologies for information dissemination;
- appreciate and comprehend the various systems technologies used in the developing of a computer-based system;
- understand that all ICT systems are built upon software engineering principles;
- understand and use Internet technologies for various tasks;
- comprehend and apply the concepts of data and information management to understand how a knowledge-driven society functions; and
- understand the social implications of ICTs and how to use ICT technologies responsibly.

[4] "A National Curriculum and Assessment Policy Statement is a single, comprehensive, and concise policy document for all the subjects listed in the National Curriculum Statement Grades R – 12" (Department of Basic Education[a], 2015).

(Department of Basic Education[b], 2011:10)

In addition to IT, Computer Applications Technology (CAT) is taught in South African schools. CAT is described as "*the study of the integrated components of a computer system (hardware and software) and the practical techniques for their efficient use and application to solve everyday problems. The solutions to problems are designed, managed and processed via end-user applications and communicated using appropriate information and communication technologies (ICTs)"* (Department of Basic Education[c], 2011:8).

CAT will ensure that learners:

- use end-user software applications proficiently to produce solutions to problems within a defined scenario;
- understand the concepts of ICTs with regard to the technologies that make up a computing system;
- understand the various technologies, standards and protocols involved in the electronic transmission of data via a computer-based network;
- use the Internet and the WWW and understand the role that the Internet plays as part of the global information superhighway;
- find authentic and relevant information, process the information to draw conclusions, make decisions and communicate the findings in appropriate presentation media and;
- recognise the legal, ethical, environmental, social, security and health issues related to the use of ICTs and learn how to use ICTs responsibly.
  (Department of Basic Education [c], 2011:10)

The practical component of this subject, which includes word processing, spread sheets, data bases, and presentations, has the largest weighting in the curriculum (60%) which makes it a relatively easy subject to pass. However, IT and CAT are rarely offered in South African schools due to the lack of resources. In 2014, of the

532 860 learners who wrote Grade 12 examinations, only 4 820 chose IT as a subject (less than 1% of learners) and 40 910 chose CAT as a subject (8% of learners) (Department of Basic Education[d], 2015).

According to Hoffman (2015) learners need to be exposed to computer subjects earlier on in their schooling, as those learners who are interested in computer subjects, will more likely choose a degree in CS or IT.

Learners who are not familiar with CS or IT have a perception that it is “too difficult” or “takes too much effort” (Hoffman, 2015) and avoid choosing it as a career choice. Learners who do choose CS or IT as a subject find the programming component difficult (Traynor & Gibson, 2004; Robins *et al,* 2003; Jenkins, 2002; Gomes & Mendes, 2007; Mendes & Marcelino, 2006). Kinnunen, McCartney, Murphy & Thomas (2007) concur that students’ chances of success in learning to programme are influenced by their way of thinking and consequently how they attempt to problem solve. According to Ismail, Ngah & Umar (2010) many students entering university have problem solving skills that are inadequate. Miliszewska and Tan (2007: 278) identify:

- lack of prior programming experience;
- lack of problem solving skills;
- the complexity of programming concepts; and
- meeting the requirements of programming syntax,

as the difficulties encountered by first year programming students. Stamouli, Doyle and Huggard (2004) concur that the majority of novice programming students who experience these difficulties could become unmotivated and negative towards their programming modules causing them to either fail the subject or drop out of the course completely.

### 1.2.2 Cognitive demands associated with programming

It is widely reported in literature that learning to programme requires cognitive abilities related to problem solving, abstract thinking, critical thinking and logical thinking.

The skills expected for computer programming include the ability to:

- define and analyse the problem (problem solving);
- develop an algorithm (solution) for solving the problem (critical thinking);
- code the computer program that implements the algorithm (technical);
- test the program to make sure it accurately addresses the problem (debugging); and
- write the specifications for the program (writing).

  (Software Specialists, 2015)

Many of these skills require higher order thinking. Piaget (1977) states that learners may not possess these skills early on in their lives, but as the years progress students will mature and develop as they attend school and HEIs. However, research indicates that very few students are able to engage with and solve programming problems that involve critical thinking (Gomes & Mendes[b], 2007). Critical thinking is one of the most important mental tools that learners must have to become competent computer programmers, as problem solving forms the foundation on which computer programming is built (deRaadt, 2008). Problem solving can be defined as "*the process of working through details of a problem to reach a solution. Problem solving may include mathematical or systematic operations and can be a gauge of an individual's critical thinking skills*" (Business Dictionary, 2015).

According to the Organisation for Economic Co-operation and Development (OECD) problem solving abilities of students world-wide are declining (OECD, 2004). Muller and Haberman (2009: 2) indicate that students often have difficulties with "*problem decomposition, developing an efficient solution, and using previously seen solutions for elementary problems*".

In this study it will be determined if there is a relationship between a novice South African programming student's problem solving ability and their performance in programming modules.

### 1.2.3 Students' background

Research has shown that a variety of aspects of a student's background have an influence on their academic performance, (Yorke & Longden, 2004; OECD, 2004). In the next section, the pre-entry attributes that may have an influence on a student's ability to be successful in a programming module (see Bergin & Reilly, 2005; Byrne & Lyons, 2001; Gomes & Mendes, 2007a, 2007b; Kinnunen, McCartney, Murphy, & Thomas, 2007; Wilson & Shrock, 2001), are discussed.



#### 1.2.3.1 Socio-economic status

Socio-economic status (SES) "*is commonly conceptualized as the social standing or class of an individual or group. It is often measured as a combination of education, income and occupation. Examinations of socio-economic status often reveal inequities in access to resources, plus issues related to privilege, power and control*" (APA, 2014).

The relationship between socio-economic status and academic performance is well documented and indicates that students from a higher SES will perform better academically due to a home environment more supportive of learning and parents that prioritise education (Ndletyana, 2014).

Social classes are generally grouped according to income distribution: lower-class, middle-class and upper-class (Visagie, 2013). However, in South Africa, which is characterised by large inequalities in earnings, the middle-class, as depicted in Figure 1.2, is divided into further groups[5] (Masemola, van Aardt & Coetzee, 2012:2), namely: lower emerging middle-class, emerging middle-class, realised middle-class, upper middle-class and emerging upper-class.

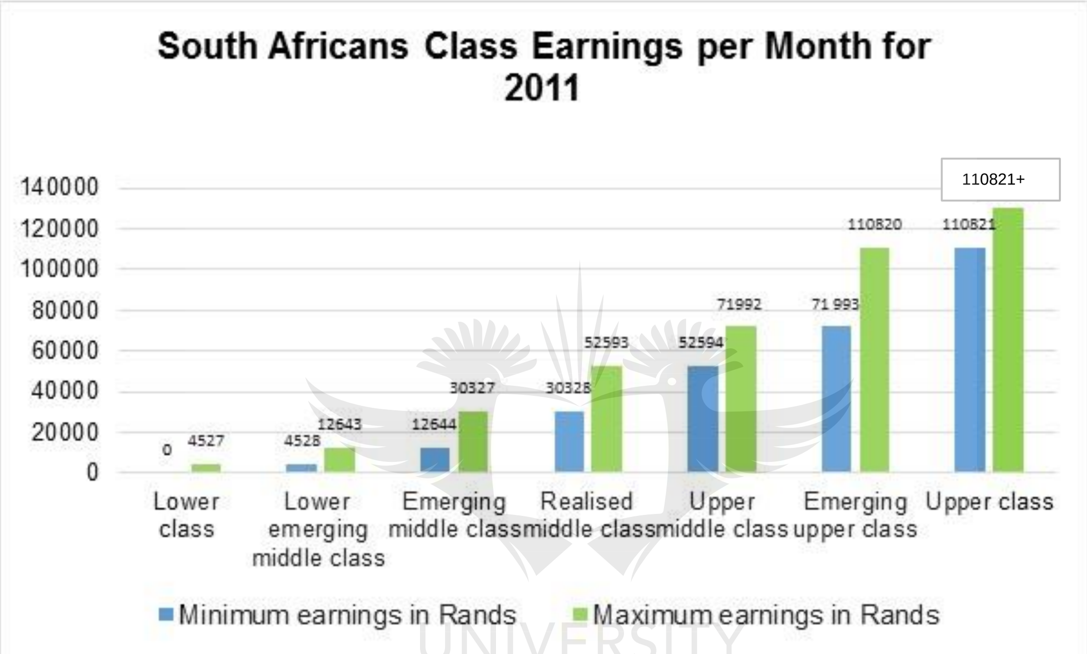



**Figure 1.2:** South Africans class earnings per month for 2011 (Adapted from Masemola, van Aardt & Coetzee, 2012: 2).



Despite the end of the apartheid in 1994 South Africa has the highest income inequality in the world measured by the Gini Index[6] which has remained relatively unchanged between 2000 (63.5%) and 2011 (63.6%) (Trading Economics[b], 2015). Several international studies (Considine & Zappalá, 2002: 92), confirm that learners from lower-SES class families' exhibit educational patterns of:

[5] Income per month for a family of 4 in 2011.
**[6]** The Gini index is the "standard economic measure of income inequality varying between 0% (perfect equality) and 100% (perfect inequality)" (Trading Economics[b], 2015)

- having lower levels of literacy, numeracy and comprehension;
- having lower retention rates;
- having lower higher education participation rates;
- exhibiting higher levels of problematic school behaviour;
- being less likely to study specialized mathematics and science subjects;
- being more likely to have difficulties with their studies and display negative attitudes towards school; and
- having less successful school-to-labour market transitions.

According to Okafor (2007: 11) "*lower income children have less stable families, greater exposure to environmental toxins and violence, and more limited extra-familial social support networks*". A REAP (Rural Education Access Programme, 2008) student advisor explained a disadvantaged home life in rural areas as one where:

- learners come from a home where there is no electricity and they have to study by candlelight;
- learners have to work after school by fetching water for the family and doing other chores like washing dishes, which impacts on their study time; and
- learners worry about their parent's health and lack of finances.



Equity, access and success in schools can be directly related to the socio-economic status of a learner's family (Msila, 2014). Students from a lower SES are thus more likely to experience a profound number of problems and challenges in their first year of study, which could have a direct impact on their academic achievement.

#### 1.2.3.1.1 Race[7] and socio-economic status

According to South Africa's 2011 census survey (Statistics South Africa, 2012), the average monthly household income for black citizens was R5 051 per month which is approximately one 6th of the average household monthly income of the white population. Considering that the South African population comprises 79.2% of blacks, 8.09% of whites and the remaining 11.9% of the population being either Coloured, Indian or Asian, these statistics show that disparities between South Africa's major racial groups still exist (De Silver, 2013). A large number of South Africans, the majority being black, fall into the lower-class socio-economic category and approximately 25.5% are unemployed (Trading Economics[a], 2015).

Due to historical legacies, the home and educational environments of most black learners, do not complement educational performance, as historically black and rural schools are often overcrowded and under-resourced. Many black parents themselves are not educated and therefore lack the knowledge to assist their children with their homework making it difficult for them to succeed academically (Ndletyana, 2014).

In this study it will be determined if there is a relationship between a novice South African programming student's socio-economic status and their performance in programming modules.

#### 1.2.3.2 Educational background

To this day, the schooling system in South Africa suffers from the legacies of apartheid rule (1948-1994). Prior to democracy in 1994, the schooling system was

[7] South Africans are officially classified by race according to four racial categories namely, black, coloured, Indian/Asian or white.

characterised by disparities in many ways. For example, the government funded former 'black schools' differently to former 'white schools' (Boddy-Evans, 2001; Taylor, Fleisch & Shindler, 2008). 'Black' schools received two and a half times less funding than 'white' schools' in urban areas and five times less funding in rural areas (Fiske & Ladd, 2004). This entrenched the inequality in the provision of education and educational resources.

After the fall of the apartheid regime in 1994, South Africa's first black president, Nelson Mandela, made education the number one priority of his new administration. Section 29 (1) (a) of the South African Constitution states that all South African learners should have equal access to teaching and learning, facilities and educational opportunities (Gardiner, 2008). South African public schools are classified and grouped into "quintiles". Quintile 1 schools are the 'poorest', and quintile 5 are the 'least poor'. Quintiles are determined by considering the poverty of the community in the surrounding area of the school as well as the schools infrastructure. Funding from the state is determined by the quintile level of the school. Schools in quintiles 1, 2 and 3 are declared non-fee paying schools and the state allocates more funding to these schools to compensate for their loss of income. Non-fee paying schools make up approximately 60% of public schools in South Africa (Grant, 2013:1).



The National and Provincial breakdown of the quintiles is highlighted in Table 1.1.

**Table 1.1:** National Poverty Table for 2014 (Source: Grant, 2013: 1)

| South African National Poverty Table for 2014 | | | | | |
|---|---|---|---|---|---|
| | **National Quintiles** | | | | |
| **Province** | **1** | **2** | **3** | **4** | **5** |
| Eastern Cape | 27% | 25% | 20% | 17% | 11% |
| Free State | 21% | 21% | 22% | 21% | 15% |
| Gauteng Province | 14% | 15% | 18% | 22% | 31% |
| KwaZulu Natal | 22% | 23% | 20% | 19% | 16% |
| Limpopo Province | 28% | 25% | 24% | 15% | 8% |
| Mpumalanga | 23% | 24% | 22% | 18% | 14% |
| Northern Cape | 22% | 19% | 21% | 21% | 17% |
| North West Province | 26% | 22% | 21% | 18% | 14% |
| Western Cape | 9% | 13% | 18% | 28% | 32% |
| South Africa | 20% | 20% | 20% | 20% | 20% |

The Department of Basic Education received a share of approximately 20% (R254 billion) of the national budget for 2015 (SA news.gov.za, 2014). This money will be used to fund the building of 433 new schools and to improve the infrastructure of existing schools.

Although South Africa has one of the highest education budgets in the world (South Africa.info[a], 2013) the inequality within the education system is still evident. Spaull identifies two education systems that exist in South Africa. On the one hand, dysfunctional schools that are found in black townships and rural areas, and on the other hand, functional schools situated in former white urban areas. Table 1.2 highlights the differences in these two schooling systems as recognised by Spaull (2012).

**Table 1.2:** Characteristic features of South Africa's two education systems (Spaull, 2012).

| Dysfunctional Schools (75% of schools) | Functional Schools (25% of schools) |
|---|---|
| Weak accountability | Strong accountability |
| Incompetent school management | Good school management |
| Lack of culture of learning, discipline and order | Culture of learning, discipline and order |
| Weak teacher content knowledge | Adequate teacher content knowledge |
| High teacher absenteeism | Low teacher absenteeism |
| Slow curriculum coverage, little homework or testing | Covers the curriculum, weekly homework, frequent testing |
| Extremely weak learning: most students fail standardised tests | Adequate learner performance |
| High repetition and dropout (Grade 10 – 12) | Low repetition and dropout (Grade 10 – 12) |

The National Education Infrastructure Management System (NEIMS) Report, published in May 2011, provides detailed statistics on the lack of resources at public schools across South Africa. The report shows that of the 24 793 public ordinary schools:

- 3 544 South African schools have no electricity and 804 schools have an unreliable electricity source;
- 2 402 schools have no water supply and 2611 schools have an unreliable water supply;
- 913 schools have no toilets and 11 450 schools are still using pit latrine toilets;
- 22 938 schools have libraries but no books, while 19 541 do not even have a library;
- 21 021 schools do not have any laboratory facilities;
- 2 703 schools have no boundary walls/ fences;
- 19 037 schools do not have a computer centre;
- There are over 400 schools in the Eastern Cape that are still made out of mud.

  (Equal Education, 2014)

In recent years, national and international surveys on educational achievement in literacy, numeracy and science have been assessed in South African schools. These are: The Trends in International Mathematics and Science Study (TIMSS – conducted in 2011), Progress in International Reading Literacy Study (PIRLS – conducted in 2011), Southern and East African Consortium for Monitoring Education Quality survey (SACMEQ – conducted in 2007), and the local Annual National Assessments (ANA – conducted in 2013). The results of these surveys show that South African learners underperform in literacy, numeracy and science, compared to their international counterparts (Taylor, van der Berg & Burger, n.d.). From the preceding paragraphs, it is clear that a large portion of students are poorly prepared by the education system through which they came (van der Westhuizen, 2013).

Many of the students who enrol for the National Diploma Business Information Technology (NDBIT) at a Johannesburg City University (referred to as JCU[8]), and the National Diploma Information Technology (NDIT) at a Pretoria City University (referred to as PCU[9]) where this study was conducted originate from former 'black schools' that were beset with the problems described above. This may offer possible explanations for the poorly developed skills of students who at universities struggle to cope with the demands of higher learning.

In this study it will be determined if there is a relationship between a novice South African programming student's educational background and their performance in programming modules.

1.2.3.3 Performance in school mathematics

Several studies have shown a positive relationship between performance in mathematics and computer programming success (for example, see Byrne & Lyons, 2001; Wilson & Shrock, 2001; Gomes & Mendes, 2008; Bergin & Reilly, 2005; Hu, 2006). Research done by Gomes, Bigotte, Carmo and Mendes between 2005 and 2006 show that the majority of novice programming students do not possess the necessary basic mathematical concepts and that reflects in their problem solving ability and results in poor programming skills development (2006). These researchers state that students have the following mathematical limitations when it comes to studying computer programming:

- students do not have enough basic mathematical concepts concerning the number theory;
- students have difficulties in transforming a textual problem into a mathematical formula that solves it;

[8] Pseudonym
[9] Pseudonym

- students do not recognise geometric figures;
- students have difficulty understanding the problem description;
- students are unable to define comparison criteria;
- students lack trigonometric concepts or are unable to apply them to solve exercises;
- students have difficulty understanding calculus;
- students have weak abstraction levels; and
- students lack logical reasoning.

(Gomes, Bigotte, Carmo & Mendes, 2006: 3,4)

Prior to the new South African National Senior Certificate (NSC) curriculum, mathematics was not a compulsory subject and learners who elected to take it could either do so on a higher grade or standard grade level (Pasensie, 2012). In a report by Aarnout Brombacher (Clark, 2012), only 60% of students opted to take mathematics between 2000 – 2005. The majority of these learners chose to take mathematics on the standard grade level with the result that, of the whole Grade 12 cohort during that period, only 5.2% passed higher grade mathematics. The new NSC curriculum was introduced at the end of 2008, and learners now must choose between either mathematics or mathematical literacy for Grades 10 – 12 (Spangenberg, 2012). Some of the differences in these two subjects are shown in Table 1.3.

**Table 1.3:** Differences in content between mathematics and mathematical literacy as prescribed by the National Curriculum Statement (Source: Spangenberg, 2012: 4)

| Mathematics | Mathematical Literacy |
|---|---|
| Number and number relationships:<br>• Convert between terminating or recurring decimals<br>• Fluctuation foreign exchange rate | Number and operations in context:<br>• Percentage<br>• Ratio<br>• Direct and inverse proportion<br>• Scientific notation |
| Functions and algebra:<br>• Graphs to make and test conjectures and to generalise the effects of the parameters *a* and *q* on the graphs | Functional relationships:<br>• Numerical data and formula in a variety of real-life situations, in order to establish relationships between variables by finding the dependent variable and the independent variable. |

| Mathematics | Mathematical Literacy |
|---|---|
| • Algebraic fractions with monomial denominators<br>• Linear inequalities in one variable<br>• Linear equations in two variables simultaneously | |
| Space, shape and measurement:<br>• Volume and surface area of cylinders<br>• Co-ordinate geometry<br>• The trigonometric functions sin$\vartheta$, cos$\vartheta$ and tan$\vartheta$, and solve problems in two dimensions by using the trigonometric functions in right-angle triangles. | Space, shape and measurement:<br>• International time zones<br>• Circles<br>• Draw and interpret scale drawings of plants to represent and identify views |
| Data handling and probability:<br>• Measures of dispersion (range, percentiles, quartiles, interquartile and semi-interquartile range)<br>• Frequency polygons<br>• Venn diagrams | Data handling:<br>• Investigate situations in own life by formulating questions on issues such as those related to social, environmental and political factors, people's opinions, human rights and inclusivity<br>• Collect or find data by appropriate methods (e.g. interviews, questionnaires, the use of databases) suited to the purpose of drawing conclusions to the questions<br>• Representative samples from populations |

Mathematical literacy was specifically introduced as an intervention to improve the numeracy skills of South African learners in response to poor performance in mathematics in the past (Pasensie, 2012). For many learners, especially learners from rural areas, mathematical literacy may be their only chance of acquiring any mathematical skills at all. Table 1.3 reveals that mathematics and mathematical literacy relate to each other, but differ in terms of their nature.



In spite of the restructuring of the mathematical curriculum, the failure rate of Grade 12 mathematics in South African schools remains high. In 2014 the total cohort of students who took mathematics as a subject was only 42% of learners and of those learners, only 35.1% passed with 40% and above (Department of Basic Education, 2015[d]). The remaining 58% of learners took mathematical literacy of which 59.5% passed with 40% and above (Department of Basic Education[d], 2015).

Universities, in an effort to address the issues impacting on the teaching and learning of mathematics in the South African schooling system, have started to introduce bridging courses aimed at improving students mathematical knowledge or extending their qualifications to accommodate the students' under-achievement (Mji & Makgato, 2006; Jennings, 2009).

In this study it will be determined if there is a relationship between a novice South African programming student's performance in school mathematics and their performance in programming modules.

#### 1.2.3.4 English language proficiency

Language and academic success are deemed to be closely related. Academic language proficiency is far more difficult to acquire in a second language. In South Africa, eleven official languages namely; Afrikaans, English, isiNdebele, isiXhosa, isiZulu, Sesotho, Sepedi, Setswana, siSwati, Tshivenda and Xitsonga are recognised with the majority of South Africans' mother tongue being isiZulu (SouthAfrica.info[b], 2013). English however is the language of teaching and learning at most schools and higher education institutions.

According to Nash, learning to programme involves a wide range of language skills (Nash, 2006:3):

- Programming includes grammatical and syntactic structures;
- Theoretical concepts rely on technical jargon;
- System specifications require verbal comprehension;
- Business models are described in terms of logical concepts;
- Interpersonal communication skills are essential for effective management.

Maharaj and Gokal (2006) state that students who pass Grade 12 English as a first language have twice the likelihood of passing a programming module than those students who do not. Several universities in South Africa have researched the relationship between language and success in ICT-related programmes:

- *University of Cape Town:* Seymour and Fourie (2010) suggest that a students' home language influences his or her Information and Communication Technology[10] (ICT) attitude negatively if their home language is not English. For example, one of their ICT students expressed that "*he did not feel like doing the work because it was in English*". Another student said that "*he would do the work in English at University but when he got home, he really did not care about it, because it was in a different language*". The non-first language English speaking participants in Seymour and Fourie's (2010) study, felt that their home language had a negative impact on their ICT capabilities in contrast to the first language English speaking participants who felt that their home language had a positive impact on their ICT capabilities.

- *University of KwaZulu-Natal:* In a study conducted by Pillay and Jugoo (2005) at *the* University of KwaZulu-Natal and the Mangosuthu Technikon, results showed that students whose first language was English (54% of the student population), performed better in programming modules than students whose first language was not English.

- *University of the Witwatersrand:* Rauchas, Konidaris, Rosman and Sanders (2006) state that many of the programming students are confident in their English abilities however; their actual language ability may be poorer than they perceive it to be. Their study revealed that English as a first language is a much better predictor of a student's success in an IT course than Grade 12 mathematics, the results of which the University of the Witwatersrand use to select their programming students.

Whilst the language-medium pre-entry attribute cannot be isolated as the main reason for a programming student's under achievement, in the minds of the

[10] ICT refers to "technologies that provide access to information through telecommunications. It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and other communication mediums." (Techterms.com, 2015)

abovementioned educators, it is one of the most important pre-entry attributes (Rauchas *et al*, 2006).

In this study it will be determined if there is a relationship between a novice South African programming student's performance in English at school level and their performance in programming modules.

#### 1.2.3.5 Digital literacy

In the 21st century learners are "growing up digital". Their view of the world is very different to their parents and teachers due to access to information, people, and ideas from media such as email, message boards, Internet telephony, chat rooms, instant services and social media websites like Facebook, twitter and Instagram. Not only have social communities grown, the Internet also offers limitless information. In this context, Martin writes that "*out of all of the challenges offered by a digitally infused society, the question of how individuals can understand, and cope with, the digital world becomes a significant one*" (2006: 7). It can be deduced that being digitally literate is not only being proficient in the use of computers but also having the skills needed for reading and writing with them (Kope, 2006). Digital literacy can therefore be seen as more than mastering a specific skill; it is achieved when certain digital competencies are thoughtfully deployed in authentic life situations in solving a problem or completing a task (Martin, 2006).

In the context of life, work and education it is important for an individual to be aware of their own digital development and to realize that digital literacy is an ongoing process that depends on the needs of the situation.  Being digitally literate is a desirable state in modern society. However, not all members of all societies are equally digitally literate. In South Africa, a developing country, this state of affairs is particularly evident as unequal access to ICT's persists (Czerniewicz & Hodgkinson-Williams, 2005). In the 1990s, the "digital divide" was characterized as a gap in the access to and use of technology that transformed into "*inequities in educational, economic and social opportunities among sectors of the population*"

(Burkhardt, Monsour, Valdez, Gunn, Dawson, Lemke, Coughlin, Thadani & Martin, 2003: 7). However, digital access today is more a financial issue. Access to the Internet in homes is increasing and schools are expecting more learners to access the Internet for homework and projects. With a higher demand on bandwidth, learners from low-income families are at a disadvantage. There is also pressure for schools to provide Internet access to all learners (Burkhardt *et al*, 2003).

It has been widely observed that in Africa and specifically in South Africa that the majority of people may not have computer access but do have mobile phone access, therefore the Internet is predominately accessed via mobile phones and not computers (Lemphane & Prinsloo, 2013). According to Deumert (2010: 1) 80% - 90% of the South African population are regular users of mobile phones. However, there are still a number of South African first year students who only gain exposure to any form of technology when they first enrol at university.

In this study it will be determined if there is a relationship between a novice South African programming student's digital literacy and their performance in programming modules.

#### 1.2.3.6 Previous programming experience

Previous computer programming experience at school level has been identified in the literature as having a positive influence in programming students success (Kumwenda, Rauchas & Sanders, 2006; Rountree, Rountree, Robins & Hannah, 2004; Wiedenbeck, 2005; Pedroni, Oriol & Meyer, 2009; Holden & Weeden, 2003; Sheard, Carbone, Markham, Hurst, Casey & Avram, 2008; Hagan & Markham, 2000; Blewett & Achmad, 2005). Students studying a computer programming course enter the qualification with varying degrees of experience ranging from none whatsoever, to being competent programmers (Holden & Weeden, 2003). The students who have some degree of programming experience could have received this experience in a number of ways: selected as a high school subject, self-taught, work experience, or a prior programming qualification (Tafliovich, Campbell & Petersen, 2013).

The subject Information Technology discussed in 1.2.1 *"focuses on activities that deal with the solution of problems through logical thinking, information management and communication. It also focuses on the development of computer applications using current development tools. The subject develops awareness and an understanding of the social, economic and other implications of using computers"* (Department of Basic Education, 2011[b]: 8). Such understanding will be achieved by providing learners with opportunities to:

- demonstrate an understanding of concepts, principles and knowledge of computers and computer applications in various disciplines;
- demonstrate an understanding of how computers impact on the management of natural resources, cultural values, socio-economic and human rights development;
- critically analyse the impact of computers on ethical, social, economic and political relations;
- work competently in a dynamic computer-using environment which includes:
    - effective communication,
    - problem-solving approaches,
    - team work,
    - responsible use of technology,
    - precision and accuracy;
- demonstrate proficiency in the use of computers in managing and critically interpreting information;
- demonstrate how the creative uses of different computer technologies facilitate human interaction;

- show proficiency in selecting and customising appropriate computer applications, hardware and media to provide and communicate innovative solutions across all sectors of society;
- design and programme well-tested and user-friendly computer-based solutions to meet specific requirements; and
- prepare for a career path, Higher Education and lifelong learning, thus enabling learners to become effective members of a computer-using society.

  (Department of Education, 2003: 9)

The programming component of the subject IT has the largest weighting in the curriculum (60%) (Department of Basic Education, 2011[b]). According to Mentz, Bailey, Havenga, Breed, Govender, Govender, Dignum & Dignum (2012), black learners believe that choosing to study an IT course will ensure a better future. However, a low pass rate has been achieved at rural schools in past years which is in contrast to a pass rate of between 90% to 100% at urban schools (Mentz *et al*, 2012).

The challenges that rural schools experience in offering IT as a subject are as follows:



- no Internet access in the computer labs;
- learners do not have computers at home to practise;
- insufficient technical assistance for the maintenance of the computer labs;
- lack of teaching support;
- learners cannot afford to buy the prescribed textbook; and
- schools experience frequent electrical outages, which impacts on the offering of the subject.

  (Varughese, 2011)

Due to these challenges, students lack the learning-by-doing aspect of studying programming (Hassinen & Mäyrä, 2006: 119). It is thus not surprising that the Grade 12 IT results from rural schools differ substantially from urban schools. These challenges also do not promote an increase in the numbers of IT learners at school level.

In this study it will be determined if there is a relationship between a South African programming student's previous programming experience and their performance in programming modules.

## 1.3 RESEARCH QUESTION

In the preceding paragraphs, it was shown that success rates in programming modules have historically been low and it was determined that success in programming modules may be influenced by particular cognitive demands associated with learning to programme. It was further shown that legacies within the South African educational system may very well influence performance in programming modules. For the purposes of this study, those legacies define the pre-entry attributes of students who enter higher education programming courses. Considering the world-wide demand for skilled programmers, it is imperative that institutions of higher learning a) consider the pre-entry attributes of students and reconsider the admission requirements for entry to programming courses, and b) redesign the pedagogical approaches towards the teaching of programming courses to accommodate the pre-entry academic deficiencies that students may have upon entering the HEI system. This research attempts to determine the pre-entry attributes of South African students and to establish whether those attributes are related to performance in the programming modules. Therefore, the research question that will guide this study is:

**To what extent do selected pre-entry attributes influence a South African students' performance in computer programming modules?**

## 1.4 AIM OF THE RESEARCH

To determine which pre-entry attributes can be used to predict student performance in computer programming modules in two South African higher education institutions.

## 1.5 RESEARCH OBJECTIVES

The objectives of the study are to determine if:

- there is a relationship between a novice South African programming student's problem solving abilities and their performance in programming modules;
- there is a relationship between a novice South African programming student's socio-economic status and their performance in programming modules;
- there is a relationship between a novice South African programming student's educational background and their performance in programming modules;
- there is a relationship between a novice South African programming student's performance in school mathematics and their performance in programming modules;
- there is a relationship between a novice South African programming student's performance in English at school level and their performance in programming modules;
- there is a relationship between a novice South African programming student's digital literacy and their performance in programming modules;
- there is a relationship between a South African programming student's previous programming experience and their performance in programming modules.

These objectives of the study informed the development of the following hypotheses:

## 1.6 HYPOTHESES

The seven pre-entry attributes identified are re-formulated as null hypotheses as follows:

$H_{01}$: There is no relationship between a novice South African programming student's problem solving abilities and their performance in computer programming modules.

$H_{02}$: There is no relationship between a novice South African programming student's socio-economic status and their performance in computer programming modules.

$H_{03}$: There is no relationship between a novice South African programming student's educational background and their performance in computer programming modules.

$H_{04}$: There is no relationship between a novice South African programming student's performance in school mathematics and their performance in computer programming modules.

$H_{05}$: There is no relationship between a novice South African programming student's performance in English at school level and their performance in computer programming modules.

$H_{06}$: There is no relationship between a novice South African programming student's digital literacy and their performance in computer programming modules.

$H_{07}$: There is no relationship between a South African programming student's previous programming experience and their performance in computer programming modules.

## 1.7 THEORETICAL FRAMEWORK

The theoretical framework underpinning this study is Lave and Wenger's theory of situated learning which implies that information is meaningful only in relation to its context (Ling & Choo, 2005) and Bourdieu's theory of cultural capital which explains that people need cultural capital to use information in appropriate ways, although this kind of capital is not equally distributed in society (Bourdieu, 1986).

### 1.7.1 Situated learning

Lave and Wenger (1990), who are often credited with starting the situated learning movement, define situated learning as "*a general theory of knowledge acquisition based on the notion that learning occurs in the context of activities that typically involve a problem, others, and a culture" they go on to state that situated learning "involves a process of engagement in a 'community of practice'*" (Smith, 2003: 2). In accordance with this view, Tiene and Ingram describe situated learning as "*learning that is located or situated in a real-world context and that is meaningful to the lives of the learners*" (2001: 67). The students who are the subjects of this course thus participate in daily life and gain different experiences before entering university as a first year programming student.

It can be deduced from these various definitions that what is learned and how it is learned and used cannot be separated.

### 1.7.2 Bourdieu's theory of cultural capital

Cultural capital, according to Bordieu and Passerson (1977), explains the difference in success between students from low-socio-economic backgrounds and students from middle to high-socio-economic backgrounds. The concept of cultural capital refers to students who represent an elite culture and who embark on their university experience with confidence because of their pre-university experience. Students who are not familiar with the elite culture find it difficult to achieve educational success at the university level due to the cultural barrier. There is effectively a discord between the culture of the home environment and the culture of the university environment that makes it difficult for students from, for example, rural communities, to integrate and succeed in a higher education institution (Longden, 2004).

Bourdieu (1977, 1984) distinguished between three forms of cultural capital, namely:

- embodied state: directly linked to and incorporated within the individual and represents what they know and can do;
- objective state: represented by objects such as books, music, paintings etc.;
- institutionalised capital: represented by an array of certificates and qualifications (credentials).

University students possess ‘embodied’ and ‘objective’ cultural capital and strive toward ‘institutionalised’ capital. Bourdieu disagrees that academic success or failure is solely due to natural aptitudes such as intelligence. He believes that a learner’s success at school is related to the amount and type of cultural capital that the learner has inherited from the family milieu rather than by measures of individual talent or achievement (Bourdieu, 1977, 1984).

## 1.8 SIGNIFICANCE OF THE RESEARCH

In the context of this study, it is important to take cognisance of research published both nationally and internationally. Research on students’ backgrounds and the cognitive demands of programming is reported on in research papers, books and journals. A search conducted on the Africa Wide: NiPAD database, which includes South African and African studies on thesis/ dissertations and periodicals published in and about South Africa and multidisciplinary information on Africa on 18 July 2013, resulted in the following:

| Key words used in the search | | South African Research (Nexus) Number of records |
|---|---|---|
| 1. | Students background and problem solving | 1* |
| 2. | Students background and programming | 1* |
| 3. | Background of first-year IT students | 0 |

* Same article

**Title:** An investigation of student's knowledge, skills and strategies during problem solving in object-oriented programming

**Author:** H.M. Havenga

**Dissertation:** Dh.D. in Mathematics, Science and Technology (Technology Education) - University of South Africa, 2008

**Abstract:** The objective of this study was to identify cognitive, metacognitive and problem-solving knowledge, skills and strategies used by successful and unsuccessful programmers in object-oriented programming (OOP). These activities were identified and evaluated in an empirical study. A mixed research design was used, where both qualitative and quantitative methods were applied to analyse participants' data. As a qualitative research practice, grounded theory was applied to guide the systematic collection of data and to generate theory. The findings suggested that successful programmers applied significantly more cognitive, metacognitive and problem-solving knowledge, skills and strategies, also using a greater variety than the unsuccessful programmers. Since programming is complex, it was proposed that a learning repertoire based on the approaches of successful programmers, serve as an integrated framework to support novices in learning Object Oriented Programming. Various techniques should be used during problem solving and programming to meaningfully construct, explicitly reflect on, and critically select appropriate knowledge, skills and strategies so as to better understand, design, code and test programs. Some examples of teaching practices were also outlined as application of the findings of the study.

A search conducted on the OCLC (Online Catalogue of the Library of Congress) database (which includes World Category Dissertations) on 18 July 2013, resulted in the following:

| Key words used in the search | | International Research (OCLC) Number of records |
|---|---|---|
| 1. | Student background and problem solving | 1 |
| 2. | Student background and programming | 0 |
| 3. | Background of first-year IT students | 2 |

These studies include the following theses:

1. **Title:** Applying teaching principles in information and communication technology at a University of Technology
   **Author:** P. Callaghan
   **Dissertation:** Thesis (DTech. Degree in Education) - PCU, 2008.
   **Abstract:** This study describes the action research process that was undertaken to develop a model of teaching principles which can be applied in a framework to support and improve teaching at a University of Technology in the challenging Information and Communication Technology (ICT) field. These challenges include the changing ICT field, as well as the altering educational environment. Lecturers with varying training and experience in teaching practices have to teach students from vastly different cultural, personal and educational backgrounds in a variety of subjects on the higher cognitive levels, featuring problem solving, technical characteristics, modeling and abstract thinking.

2. **Title:** Factors impacting on first-year students' academic progress at a South African University
   **Author:** V.F. McGhie
   **Dissertation:** Thesis (D.Phil.) - University of Stellenbosch, 2012.

**Abstract:** This research project explored the learning experiences of two groups of first-year students in the Faculty of Economic and Management Sciences, University of the Western Cape during the course of 2009/2010. The aim was to obtain insight into the learning challenges that these students encountered and the reasons why some of them were less successful in the learning process, while others were successful. The perspective of this was therefore student centred. The project was undertaken against the backdrop of a higher education institution that caters mainly for so-called ’disadvantaged’ and ’underprepared’ students.

Such students come predominantly from marginalised and poorly resourced education environments and socio-economic backgrounds, which suggests that they would find higher learning challenging and, as a result, would most likely experience failure in the learning process.

**3.** **Title:** The predictive value of pre-entry attributes for student academic performance in the South African context.

**Author:** A. van Zyl

**Dissertation:** DEd. et Phil – University of Johannesburg, 2010.

**Abstract:** Poor academic performance and high dropout rates are of particular concern in South African higher education in general, and also at the institution where this investigation was conducted. The challenges facing South African higher education include a highly diverse student population, with many under-prepared students, who find coping with the academic and social demands of higher education a difficult task to accomplish. From an institutional perspective, it is important to be able to identify students who are at greater risk of not achieving academic success, since these students will often not seek help themselves. An institutional reaction to the situation described above should include a comprehensive predictive model, aimed at accurately identifying at-risk students as early as possible. This will enable the institution to provide them with early targeted assistance. One part of such a model should focus on the initial transitions students make upon their arrival at higher education institutions.

The pre-entry attributes with which a student arrives at the institution have been found to be good predictors of student success and retention during the initial phases of their transition into higher education. The purpose of this study was therefore to investigate the predictive value of a variety of pre-entry attributes in terms of predicting the academic success and retention behaviour of students entering the university for the first time. The pre-entry attributes that proved to be good predictors were used to create student profiles that would allow the institution and the different faculties to identify potential at-risk students at an early stage.

A search done on Google Scholar on 2 September 2014, resulted in the following related journal articles and conference papers:

| Year | Authors | Title | Summary | Cited by |
|---|---|---|---|---|
| **2000** | Jenkins T. & Davy J. | Dealing with Diversity in Introductory Programming | Jenkins and Davy discuss how students approach learning to program from a wide variety of backgrounds, yet they are all taught and assessed in the same way. This paper considers the diversity of the introductory programming class, and describes some attempts to handle this diversity in the teaching programmes at the School of Computing at the University of Leeds. | 38 |
| **2001** | Wilson B.C. & Shrock S. | Contributing to Success in an Introductory Computer Science Course: A Study of Twelve Factors. | This study was conducted to determine factors that promote success in an introductory college computer science course. The model included twelve possible predictive factors including math background, attribution for success/failure (luck, effort, difficulty of task, and ability), domain specific self-efficacy, encouragement, comfort level in the course, work style preference, previous programming experience, previous non-programming computer experience, and gender. The study revealed three predictive factors in the following order of importance: comfort level, math, and attribution to luck for success/failure. Comfort level and math background were found to have a positive influence on success, whereas attribution to luck had a negative influence. | 218 |
| **2001** | Byrne P. and Lyons G. | The Effect of Student Attributes on Success in Programming | This paper examines the relationship between student results in a first year programming module and predisposition factors of gender, prior computing experience, learning style and academic performance to date. The study does not suggest that any dominant attributes are related to success in programming however, there are some interesting outcomes which have implications for teaching and learning. | 168 |
| **2004** | Rountree N., Rountree J., Robins A., & Hannah R. | Interacting Factors that Predict Success and Failure in a CS1 Course. | In this paper, Rountree *et al* reassess the data from a survey conducted in 2002 by using a decision tree classifier to identify combinations of factors that interact to predict success or failure more strongly than single, isolated factors. | 49 |
| **2005** | Wiedenbeck S. | Factors Affecting the Success of Non-majors in Learning to Program | In this study Wiedenbeck develops and empirically tests a model integrating three factors of importance in learning to program: previous programming experience, perceived self-efficacy, and knowledge organization. The participants were non-majors. The findings showed that perceived self-efficacy increased significantly during a semester course. Previous experience affected perceived self-efficacy but not knowledge organization. | 82 |
| **2005** | Bergin S. & Reilly R. | Programming: Factors that Influence Success. | This paper documents a study, carried out in the academic year 2003-2004, on fifteen factors that may influence performance on a first year object-oriented programming module. The factors included prior academic experience, prior computer experience, self-perception of programming performance and comfort level on the module and specific cognitive skills. The study found that a student's perception of their understanding of the module had the strongest correlation with programming performance. In addition, Leaving Certificate (LC) mathematics and science scores were shown to have a strong correlation with performance. A regression module, based upon a student's perception of their understanding of the module, gender, LC mathematics score and comfort level was able to account for 79% of the variance in programming performance results. | 104 |

Most of the studies mentioned in the preceding paragraphs are almost a decade old and may be irrelevant for contemporary demands. "*Programming is changing, the PC era is coming to an end, and software developers now work with an explosion of devices, job functions, and problems that need different approaches from the single machine era*" (Dumbill, 2013:1).

This study provides the prospect of obtaining insight into educational deficiencies of the students at the JCU and the PCU and the attributes that influence or promote performance in the subject Development Software 1 (Programming). The envisaged research findings, their implications and the conclusions provide an opportunity to: (1) identify a better selection process for programming students and (2) develop supporting learning activities that will assist students in becoming more successful in programming modules.

## 1.9 ABBREVIATED RESEARCH DESIGN

The overall research design of this study was that of a survey. This survey is a non-experimental, descriptive research method (Babbie, 2005).

### 1.9.1 The participants



The participants of the study were a group of:

- 186 first year students enrolled for the National Diploma Business Information Technology (NDBIT) at the Johannesburg City University;
- 193 first year students enrolled for the National Diploma Information Technology (NDIT) at the Pretoria City University.

### 1.9.2 Literature review

The research process was preceded by a thorough literature review which explored the pre-entry attributes of students' problem solving ability, socio-economic status, educational background, performance in school mathematics, English language proficiency, digital literacy and previous programming experience in relation to performance in programming modules.

### 1.9.3 Quantitative data collection

Three sets of quantitative data were collected:

- Student profile questionnaire (SPQ) (Appendix B). The SPQ was piloted before being finalised. This questionnaire was completed by students during their first year of studying computer programming.

- Various computer programming aptitude tests to determine students' logical reasoning (Appendix C), non-verbal reasoning (Appendix D), numerical reasoning (Appendix E), and verbal logic (Appendix F), which are said to be required for technical programming, were administered in the students first week of classes for the year 2013 and 2014.

- The JCU and the PCU students' exam results for Development Software 1. These examination results will be used as the dependant variable throughout the study.

### 1.9.4 Data analysis

The data from the SPQ's and computer programming aptitude tests were analysed with Statistical Package for Social Sciences (SPSS Version 22) using Pearson product-moment correlation coefficient, ANOVA and regression analysis.

#### 1.9.4.1 Pearson's correlation

A Pearson product-moment correlation coefficient (referred to as Pearson's) was the standardised measure of the strength of the linear relationship between two variables. The value of *r* identified the strength of the relationship of the variables as well as the direction of association (Pallant, 2013).

#### 1.9.4.2 Analysis of variance (ANOVA)

The analysis of variance compared the variability in scores between the different groups and the variability within each of the groups (for example: fathers level of education and mothers level of education) – represented by F. A significant F score allowed the researcher to reject the null hypothesis (Pallant 2013).

#### 1.9.4.3 Regression analysis

The regression process tested the 'goodness of fit' of the relationship between the independent variable and the dependent variable and how much variation there was by fitting the independent variables into the model. The higher the variability explained, represented by the r-square, the better the model. *"If we know the form of the relationship between things we have measured and know to be causal to something else, then we can predict the value of the caused thing"* (Byrne, 2006).

### 1.9.5 Validity and reliability

Using content validity, the researcher established the validity of the data gathering method by ensuring that the pre-entry attributes thought to be predictors of a student's success in programming modules, as outlined in the literature review, was fully represented in the Student Profile Questionnaire. Using face validity, the instrument was reviewed by the researcher's supervisor and a statistician at the institution where the study was conducted.

After five drafts the supervisor and statistician agreed that the instrument was valid and would measure what it needed to measure. The researcher then piloted the SPQ with five target respondents to investigate any problem areas with the instrument. The minor problems identified were taken into consideration and the instrument changed accordingly. Factor analysis and the Cronbach Alpha Co-efficient were used as a form of reliability. These reliability tests are discussed in more detail in Chapter 3.

## 1.10 ETHICAL ISSUES

Students were informed that the SPQ questionnaire formed part of a research project done as part of a PhD study under the supervision of Prof D van der Westhuizen from the Department of Science and Technology Education from the JCU. It was stipulated that the researcher was interested in isolating those pre-entry attributes that may influence their success in the programming modules that they were enrolled for.

Students' participation in this research was voluntary, and they could elect not to complete the aptitude tests or SPQ questionnaire. If students opted to partake in the study, they could choose to do so without fear of any harm or penalty to themselves. Individual information would never be known to anyone except the research team, and no information in the research report was released that would identify them as an individual. Their student number was requested as it would assist the researcher in obtaining information about their performance in their programming modules, which was essential for the research. However, no student numbers were published in the research report. They remained totally anonymous. The findings of the research were included in the PhD report and possibly journal publications that may emanate from the research. Students could request a copy of the PhD report on completion if they so desired.

The collected written data will be kept in storage for three years, in accordance with the regulations of the JCU and the PCU, after which it will be destroyed. It was also captured electronically in a statistical analysis software tool. Students' names however, were not captured electronically.

The electronic data will be kept for posterity for research purposes only. Students could at any stage of the research request to have their information removed from the dataset.

Students were required to complete consent forms (Appendix A) stipulating what was expected from them during the research process. Permission to conduct the research was sought from the Ethics Committee at the Faculty of Education at the JCU (Appendix G) and from the Research Ethics Committee at the PCU (Appendix H). In all cases, utmost care was taken to ensure that data was collected in a responsible way, and that data was recorded as accurately as possible.

## 1.11 PLAN OF THE STUDY

In the research that will be described in the following chapters, the link between students' performance in programming modules (dependent variable) and 7 pre-entry attributes (independent variables) will be investigated. This thesis is organized into 5 Chapters. See Figure 1.3.

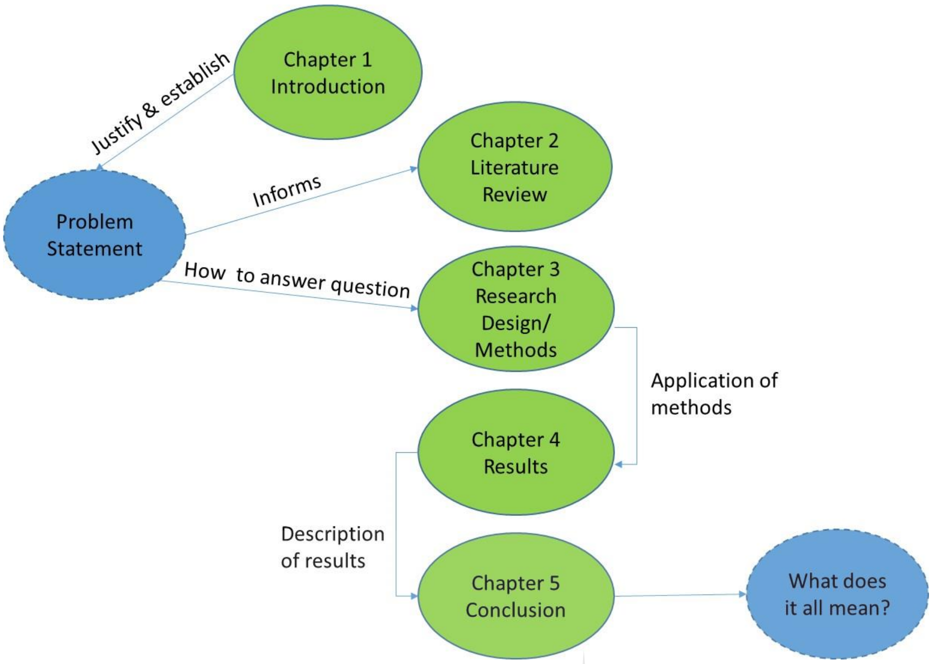



**Figure 1.3:** Chapter summary

Chapter 1 discusses the background to the study, context of the research problem, context of the study, theoretical framework, research question, aim and objectives of the study, hypotheses, motivation and significance of the research, research design, and ethical issues.

Chapter 2 is a literature study that will review literature on the pre-entry attributes thought to influence a students' ability to be successful in programming modules.

Chapter 3 discusses the research methodology of the study. It also contains a demographic description of the group of participants who took part in this study.

Chapter 4 reports on the data analysed and the interpretation of the statistics.

Chapter 5 provides an interpretation of the results of the study and the conclusions drawn from these results. It also makes various recommendations that are derived from the findings.

## CHAPTER 2

# STUDENT PRE-ENTRY ATTRIBUTES AND LEARNING TO PROGRAM

## 2.1 INTRODUCTION

In this chapter, the definition and history of computer programming is discussed followed by an in depth literature review on the pre-entry attributes that were identified in Chapter 1 and which are thought to be predictors of computer programming performance as shown in Figure 2.1.

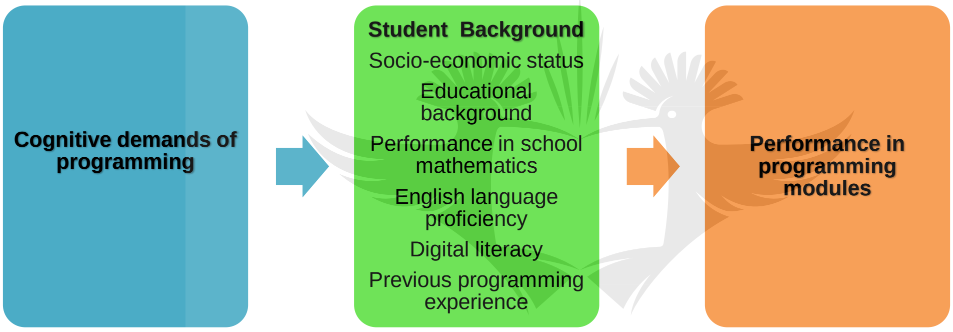



**Figure 2.1:** Pre-entry attributes thought to determine a student's performance in programming modules



## 2.2 HISTORICAL OVERVIEW

### 2.2.1 The development of the computer

Computer Science (CS) and Information Technology (IT) as academic courses are very young, especially when compared to other courses, such as education, engineering and medicine, (Nahapetian, 1979). A clothing manufacturer, Joseph Jacquard, who in 1801, wanted to automate the weaving process invented the first "computer".

Jacquard designed punched cards to create a desired pattern that could be used on the looms to produce high-quality products within the clothing industry. Instead of an apprentice manually changing every row to produce another pattern, the punched cards replaced the apprentice. However, the importance of this breakthrough for computing was profound. Jacquard had acquired the ability to capture his knowledge in a machine-readable form so that a machine could accomplish the same task automatically. The idea of computing and programming was born (Essinger, 2004).

Jacquard's invention had an influence over other scientists and inventors. One such inventor, Charles Babbage, who was a mathematics professor at the University of Cambridge, was interested in automatic computation. Influenced by Joseph Jacquard and extending the ideas of others, such as Pascal and Leibnitz, Babbage designed a mechanical calculator in 1823. The machine was called the Difference Engine and was designed to do a range of mathematical calculations. However, construction on the Difference Engine was stopped in 1832 following a dispute with the engineer, Joseph Clement and government funding stopped in 1842 (Computer History Museum, 2008). Although Babbage's ideas were ahead of their time, they influenced other scientists. Ada Augusta Byron, or Lady Lovelace, was one such scientist who worked very closely with Babbage. Lady Lovelace was responsible for organising instructions for one of Babbage's machines, namely the Analytic Engine. She is regarded as the first computer programmer (Schneider & Gersting, 2013).

Although the early mathematicians, scientists and inventors were responsible for developing the first mechanical calculators and automated programmable manufacturing devices, World War II is seen as an important time in the advancement of automated computing machines. Instructions to armies, air forces and fleets were sent by radio, so the air over Europe was full of probable interceptible messages. Whether these messages could be deciphered or not, was critical, as millions of lives depended on it.

The Enigma Machine was invented by the Germans to enable them to encipher and decipher messages during World War II. The Enigma machine was accurate, quick and complex. The Colossus was built by the British to Break the Enigma. The designer of the Colossus was Tommy Flowers who worked as a post office engineer for the British government. These were the world's first programmable, digital, electronic, computing devices (Computer History Museum, 2008).

The Mark I was completed in 1944 at IBM and is considered to be one of the first working general-purpose computers to complete useful mathematical work during World War II (The Centre of Computing History[a], 2014). The Mark 1 was used to help the United States Navy produce tables for aiming artillery shells and bombs. Soon thereafter, the machine known as the Electronic Numerical Integrator and Calculator (ENIAC) was completed just after the war ended. The ENIAC became the first fully electronic general-purpose programmable computer. The ENIAC was the major instrument for the computation of all ballistic tables for the U.S. Army and Air Force. "*In addition to ballistics, the ENIAC's field of application included weather prediction, atomic-energy calculations, cosmic-ray studies, thermal ignition, random-number studies, wind-tunnel design, and other scientific use.*" (The Centre of Computing History[b], 2014).



Although these early machines made important contributions to the computing field, it was only in 1951 that the first commercially viable computer known as the Universal Automatic Computer or UNIVAC I was constructed and used by the American Census Bureau. The UNIVAC was invented by Dr Presper Eckert and Dr John Mauchly, the team that invented the ENIAC computer (The Centre of Computing History[c], 2014). The American Census Bureau needed a new computer to deal with the exploding U.S. population (due to the baby boom) and the UNIVAC was perfect for handling volumes of statistical data. The IBM 701, was built soon afterwards, the first computer to be built by a company, who is today, a world leader in computing. These machines were known as first generation machines and they were bulky, expensive, slow and unreliable.

However, in 1957 computers became smaller in size and their complexity increased. This was due to the bulky vacuum tube that was used for processing and storage being replaced with a single transistor. Reliability improved and costs were reduced. Commercial computing became a reality and the “computer age” began (Schneider & Gersting, 2013).

### 2.2.2 The development of computer programming languages

Computer programming evolved as computers evolved. Computer programming, also known as software development, can be defined as the process of developing a computer program to complete a particular task (Shelly & Vermaat, 2011). The tasks are normally problems that need to be solved. “*The program is a detailed step-by-step set of instructions, also known as a sequence of actions, which tells the computer exactly what to do*” (Zelle, 2002: 1).

The process of creating a computer program can be broken down into a number of phases (Garner, 2003) as these phases make it more manageable to create a program, namely:

Phase 1: Defining the problem; In understanding the problem, the programmer will be able to determine accurate solutions to the problem. This task consists of the programmer specifying the kind of input, processing, and output required to solve the problem.

Phase 2: Planning the solution; after analysing the problem it is necessary to design a solution. Two common ways of designing the solution to a problem are to draw a flowchart (a pictorial representation of a step-by-step solution to a problem) and to write pseudocode (allows one to focus on the program logic without having to be concerned about the precise syntax of a programming language) or both.

Phase 3: Coding the program; this task involves translating the logic from the flowchart or pseudocode - or some other tool - to a programming language (a set of rules that provides a way of instructing the computer what operations to perform).

Phase 4: Test and revise the algorithm; after coding the program it is tested for syntactical errors. Errors found are fixed (debugged) and tested again until the program is error free. The computer programmer then executes (runs) the program to verify that it produces accurate results.

Early programming consisted of a person having to program and re-program close on six thousand mechanical switches for every single task that needed to be automated and executed through such computers in order for the algorithms to be executed in sequence. The father of modern-day programming is John Von Neumann, a mathematician who developed an architecture called the Von Neumann architecture (Schneider & Gersting, 2013). The Von Neumann architecture identifies the arithmetic logic unit, the control unit, the memory, and the input-output devices of a computer (Riley, 1987). Modern day computers still make use of Von Neumann’s basic architecture. He is considered as being instrumental in creating the architecture used in computers as we know them today (Schneider & Gersting, 2013).



The programming languages that computer programmers use are high-level languages. This means that the languages are designed to be understood by humans. Strictly speaking computers can only compute low-level languages or machine language. This is one of the reasons why programs are compiled, as compiling a program converts the program from the high-level language to the machine language (Knox-Grant, 2006). For a computer to compute the instructions written by a computer programmer, the program has to be converted/ translated/ interpreted to machine language.

Machine language can be described as a "*programming language that can be directly understood and obeyed by a machine (computer) without conversion (translation). Different for each type of CPU, it is the native binary language (comprised of only two characters: 0 and 1) of the computer and is difficult to be read and understood by humans. Programmers commonly use more English-like languages (called high level languages) such as Basic, C, Java, etc., to write programs which are then translated into machine language (called a low level language) by an assembler, compiler, or interpreter*" (BusinessDictionary.com[a], 2014).

Algorithms are of particular importance as in many ways they form the foundation on which Computer Science and Information Technology is built. The word "algorithm" was derived from the Persian mathematician, Muhammad ibn Musa Al-Khwarizmi, who wrote one of the earliest mathematical textbooks known to man (Gulf News, 2013). The mathematical operations and procedures that he pioneered became known as algorithms. Today, algorithms are a well-ordered collection of unambiguous and effectively computable operations that, when executed, produces a result within a finite amount of time (Schneider & Gersting, 2013). In fact, Computer Science can also be viewed as the science of algorithmic problem solving.

As it became possible to write programs that could be stored within the memory of a computer, the first high-level programming language known as FORTRAN was developed (Forouzan & Mosharraf, 2008). FORTRAN pioneered the software industry as FORTRAN was the first computer programming language that resembled English-like statements or high-level statements. Soon other languages, such as COBOL, Pascal and Basic E emerged. These languages provided a platform for converting algorithms into programs that could be executed on a computer.

An algorithm is a *"step-by-step procedure designed to perform an operation, and which (like a map or flowchart) will lead to the sought result if followed correctly. Algorithms have a definite beginning and a definite end, and a finite number of steps. An algorithm produces the same output information given the same input information, and several short algorithms can be combined to perform complex tasks such as writing a computer program*" (BusinessDictionary.com[b], 2014). For example, in order to solve a problem a computer programmer would develop an algorithm for the given problem, where the algorithm would then be converted into a computer program using language, such as FORTRAN or COBOL. The program would execute the instructions it contained to carry out the steps contained in the program. Such programs meant that tasks could be automated; complex mathematical calculations could be performed; and enormous amounts of information could be processed. The programming industry rapidly grew and today, complex computer programming languages, such as Java and C++ are responsible for computers being a powerful commodity to governments and organisations world-wide (Schneider & Gersting, 2013).



As computers and computer programming languages evolved it became evident that it was critical to ensure that there were well-trained computer programmers available to develop solutions and write computer programs. To this end, the Association for Computing Machinery was established in 1947, to address the needs of workers that were employed to perform computer programming tasks. It was nearly two decades later that in October 1962 the first Department of Computer Science was established at Purdue University, in the United States of America (USA). One of the oldest universities in the world, the Department of Computer Science at Purdue University awarded its first Ph.D. student in 1966 and the undergraduate program was established two years later (Rice & Rosen, 1990). Computer Science as a discipline was born.

## 2.3 COGNITIVE DEMANDS ASSOCIATED WITH PROGRAMMING

Vogts, Calitz and Greyling (2010) state that while learning to program, numerous skills and processes need to be learnt concurrently and are interrelated, namely:

- learning to problem solve;
- learning the syntax of a programming language;
- learning how to use a program development environment to construct, debug and execute programs.

Students learning to programme are therefore not only faced with solving a problem, they also have to learn the syntax and semantics of a programming language and how to express solutions in a form that the computer can understand and all of this in a relatively short period of time (Mannila, Peltomäki & Salakoski, 2006).

It is difficult to determine what knowledge and skills first year programming students possess prior to their programming course. Critical thinking, also referred to as problem solving, reasoning or higher order thinking skills, can be defined as "*disciplined, self-directed thinking which exemplifies the perfections of thinking appropriate to a particular mode or domain of thought*" (Paul, 1990: 575).

Taxonomies of learning have been implemented worldwide to describe learning outcomes and assessment standards reflecting what learning stage a student is at. The original learning taxonomy developed by a psychologist, Benjamin Bloom and several of his colleagues in 1956, identify six levels of thought:

- Knowledge: rote memorization, recognition, or recall of facts;
- Comprehension: understanding what the facts mean;

- Application: correct use of the facts, rules, or ideas;
- Analysis: breaking down information into component parts;
- Synthesis: combination of facts, ideas, or information to make a new whole;
- Evaluation: judging or forming an opinion about the information or situation. (Bloom, Engelhart, Furst, Hill & Krathwohl, 1956)

These levels of thought start from the lowest order process to the highest order process with higher levels building on lower levels (Bloom *et al*, 1956). Once a student reaches the highest level they can be said to have grasped a subject matter. Blooms Taxonomy was revised in 2001 to address the differences between comprehension and application and to better define the term evaluation. The changes made to the revised taxonomy (Anderson, Krathwohl, & Bloom, 2001) are as follows:

- Remember (was knowledge);
- Understand (was comprehension);
- Apply (was application);
- Analyse (was analysis);
- Evaluate (was evaluation);
- Create (was synthesis).



According to Lister (2000) students learn to write complete programs in their first year of a programming module which falls within the last two levels of Bloom's Revised Taxonomy of teaching and learning (Anderson, Krathwohl, & Bloom, 2001). These two levels however, depend on the first four levels before a student is said to be able to grasp computer programming. For example, in computer programming, *'learning syntax'* is the lowest order process (Mayer, 2013) and efficiently utilising syntax in order to *'produce effective computer programs'* is the highest order process (Cooper, Dann, & Pausch, 2000). Gomes and Mendes (2009) agree that lecturers expect students to be able to write programs in the beginning of their programming module. These programs may be simple and grow in complexity as the module progresses; however, many students may be left behind whilst still struggling to find solutions to simple programs. This means that the complexity level at which the programming module starts, is already at too high a level for a novice programmer, which can lead to a lack of motivation and ultimately a student failing the module.

Although students have little experience programming, they do have experience solving problems in everyday life (University of Kent, 2012). Problem solving is a mental process of analysing a given problem, developing a solution to the problem and presenting the solution (Muller, 2005). When students solve problems either independently or in collaboration with other students they are learning by doing. While learning by doing is synonymous with problem solving (deRaadt, 2008) computer programming as a discipline is also synonymous with problem solving.

However, according to Gomes and Mendes (2007[a]: 2) students struggle to problem solve for the following reasons:

- Students do not fully understand the problem either because they have not interpreted the problem statement correctly or they just want to start writing code;
- Students fail to transfer the knowledge that they have already acquired from past problems over to new problems;
- Students who take too long to find a solution just give up trying and wait for the solution to be given to them;
- Many students don’t have enough mathematical and logical knowledge;
- Students lack specific programming expertise and struggle to detect simple syntactical and logical programming errors.

Muller and Haberman (2009), believe that more attention should be paid to a novice programming student's problem-solving abilities by encouraging them to practice problem solving, as learning to solve problems algorithmically contributes to learning to program. Students need to think about the processes they go through in solving everyday life problems and look at how to use the same processes to develop algorithms for example: "*they need to identify things that are familiar to them, divide the problem into smaller problems and use existing solutions"* (Dale, McMillan, Weems, & Headington, 2003), the very same things that Gomes and Mendes identify as what students struggle with.

## 2.4 STUDENT BACKGROUND

Tinto (1993) states that the degree to which a student can become a part of a learning environment both academically and socially depends largely on his/ her pre-entry attributes such as prior schooling, family background, competences, aspirations and goals. Students' backgrounds and experiences prepare them for their integration into higher education.

A detailed review of the literature from both a theoretical and empirical point of view, on the remaining pre-entry attributes which are thought to have an impact on student's performance in programming modules will be discussed next.

### 2.4.1 Socio-economic status

The relationship between a student's socio-economic status (SES) and academic performance is well documented and intimates that students from an advantaged background will perform better academically (Howie, Scherman & Venter, 2008; Collier & Morgan, 2008; Kuh, Kinzie, Buckley, Bridges & Hayek, 2007; Wells, 2008; Fleisch, 2007; REAP, 2008). Socio-economic status is often measured as a combination of education, income, and occupation. *"It is commonly conceptualized as the social standing or class of an individual or group"* (APA, 2014). Cultural capital includes culture-based elements that help define a person's class (Wells, 2008). Cultural capital is usually inherited from one's family and can play a role in either overcoming social barriers or reinforcing them. Such barriers may be associated with parental income, parental education, learners schooling, ethnicity and culture, which indicate symbolic wealth. Although similar, the constructs of social capital and cultural capital are different. Social capital includes the *"social and personal connections that people capitalise on for interpersonal assistance and personal gain",* which for students is either developed at school or at home or usually both (Wells, 2008). The culture-based factors play an important role in developing the appropriate cultural and social capital needed to succeed in higher education (Devlin, 2011).

#### 2.4.1.1 Parents level of education and students' academic achievement

First generation students are students whose parents have not completed a university degree (Collier & Morgan, 2008). Being a first generation student is deemed to be one of the most important predictors of poor academic performance (Kuh *et al*, 2007). First generation black students (who constitute the vast majority of the enrolment at South African universities) find the transition from school to university especially challenging, since they typically come from historically poor educational backgrounds. Statistical data reveals that first generation students are less likely to graduate with a university degree than students who have one or both parents who have attained a higher education (National Center for Educational Statistics, 2005). One of the reasons for this could be that the priorities of first generation students are different to traditional students (Devlin and McKay, 2011: 3). First generation students':

- expectations of lecturers, lectures, exams and university as a whole are unrealistic;
- aspirations may be lower than those of a traditional student;

- self-confidence may be lacking, resulting in their reluctance to ask for help from academic staff;
- computer, academic, writing, language and research skills may not be as good as the traditional students;
- level of academic preparedness may be lower;
- may be under more time constraints than traditional students due to having to support their family by working and studying;
- may not have a high level of support from their family especially if they are the first generation to attend university;
- may take longer to complete their studies than a traditional student;
- may have more financial pressures.

  (Devlin and McKay, 2011: 3).

In South Africa a large number of students starting at university can be classified as first generation university entrants. van Zyl, (2010) identified that 52.6% of students are first generation university entrants at the University of Johannesburg in South Africa. Not only are these students underprepared for the challenges that they will face at university but their families are also unaware of the difficulties that they will encounter (van Zyl, 2010) resulting in first generation students not being supported by their families.



2.4.1.2 Parents occupation and students' academic achievement

Parents play a significant role in their children's academic performance as educated parents would emphasise the importance of academic achievement (Nicholas-Omoregbe, 2010). *"Better educated people have a greater probability of being employed, are economically more productive and therefore earn higher incomes"* (van der Berg, 2008: 3). According to a PISA report (OECD, 2004), a learner's parental occupational status, which is strongly associated to their socio-economic status, has a strong correlation to their performance. *"Rigorous academic* *preparation, high educational aspirations and family support"* are easier to come by if the family has economic resources (Kuh *et al*, 2007: 29). Parental education results in higher earnings and thus parents are able to give their children a good school foundation. Parents of learners who struggle in certain subjects will either help them in said subjects or appoint private tutors to assist them. Learners who struggle at school and come from a poor socio-economic background, often find that their parents are academically unable to help them in specific subject content and do not have the financial aid to hire tutors to help their children. Furthermore, homes in rural areas are often not conducive to studying; children usually share a room with more than one sibling, lack facilities such as electricity and have to study by candlelight, and are expected by parents to do chores when they come home from school (Mulkeen, 2005).

#### 2.4.1.3 Students' socio-economic status and transition to higher education

Tinto (1993: 93) postulates that students need to detach themselves from the group that they were formerly associated with, i.e. family and school friends and then undergo a period of transition *"during which the person begins to interact in new ways with the members of the new group into which membership is sought*". In agreement with Tinto, Lawrence (2005) refers to universities as having certain discourses and argues that in order to be successful academically, students need to engage, master and demonstrate their capabilities in a range of these university-specific discourses. Students from a low socio-economic status may not have the relevant cultural capital or familial experience on which to rely to help them interpret the discourses that they are confronted with. Lawrence (2005: 247) highlights that a student's first year subjects are among the first and most critical of the discourses which students need to engage in, as each university subject presents its own challenges, namely:

- Subject matter: content;
- Language: language of teaching and learning;

- Cultural practices: e.g. way of dressing;
- Attendance: lectures, tutorials, practical's;
- Class participation: active, passive;
- Behaviours: consultation times, rule-governed, flexible;
- Rules: e.g. extensions, resubmissions;
- Ways of thinking: analytical, critical, surface, deep;
- Ways of writing: essays, assignments;
- Assessment: exams, assignments, orals.
  (Lawrence, 2005: 247)

Traditional students may be familiar with higher education through recall of their parents' experience and may have been prepared by them to apply appropriate approaches for success. Parents have thus inadvertently equipped the traditional students for higher education, from when they first started school (Collier & Morgan, 2008). Traditional students therefore have an advantage over first generation students, showing how differences in cultural capital can perpetuate differences in educational attainment (Bourdieu, 1984; Bourdieu & Passerson, 1977).



### 2.4.2 Educational background

In South Africa there are many indications that there is a crisis in the education system (Modisaotsile, 2012). Newspaper Headlines like: "Schooling System Failing Young People" (IOL News[a], 2011); "SA Teachers Can't Teach" (IOL News[b], 2013); "Poor Facilities Cripple Teaching" (IOL News[c], 2012); "SA's Public Schooling Gets an F" (IOL News[d], 2012); "Theft and Vandalism Cripple KZN Schools" (IOL News[e], 2008) - shows that the education system remains largely in a poor state of affairs. Poor communities, specifically those from rural areas, bear the brunt of the past inequalities (Howie, Scherman & Venter, 2008). Prior to 1994, education in South Africa was designed to privilege whites and disadvantage blacks. It has been 20 years since the end of apartheid in the country and although South Africa has one of the highest education budgets in the world (South Africa.info[a], 2013) the inequality of the education system still propagates. As a result, the South African schooling system is failing to provide higher education institutions with students that can cope with the jump from high school to higher education (Moutan, Louw & Strydom, 2013).

#### 2.4.2.1 Types of public schools

Pre-1994 ‘white schools’ were administered by the House of Assembly (HOA), ‘coloured schools’ by the House of Representatives (HOR), ‘Indian schools’ by the House of Delegates (HOD) and ‘black schools’ by either the Department of Education and Training (DET) or the various homeland Governments (SA Reporter, 2010). Former ‘Model C’ schools are schools attended by white learners under apartheid. The term is not officially used by the Department of Basic Education, but is widely used to refer to former whites-only schools administered previously under the House of Assembly.

Currently, former Model C schools have the best facilities, best teachers and best educational opportunities for learners, compared to former HOR, HOD and DET schools, although DET schools are still the worst off. All schools receive government funding, however, former Model C schools are permitted to top up their fees payable by the parents of the learners. Therefore, different Model C schools will have different budgets, different teacher to pupil ratios and different facilities based on what the parents can afford (my-cape-town-south-africa.com, 2013).

#### 2.4.2.2 Public schools’ fee structure

Public schools are classified into fee-paying schools, under which most former Model C schools fall and non-fee-paying schools, which include most township and rural schools.

Fee-paying schools which are paid by Quintiles[11] 4 and 5 are divided into three categories (News24, 2012):

- The first charge between R5 000 and R12 000 a year and have few sports facilities, extramural activities or additional subjects.
- The second charge up to R20 000 a year and offer above-average sporting facilities, extramural activities and additional subjects.
- Quintiles 5, cost up to R31 000 a year and are attended by wealthy learners who enjoy the best sports facilities, music classes, teachers for extra subjects and a wide array of extramural activities.

The names of the 'non-fee schools' are published in a Provincial Gazette and are declared 'non-fee schools' based on the economic level of the community around the school. Non-fee schools fall in the quintiles 1, 2 and 3.

2.4.2.3 Poor conditions in townships and rural schools

The prevalence of poverty in townships and rural areas is reflected in the schools within these communities. There are many problems that South African township and rural schools face, the most common of them being a lack of basic facilities such as water, electricity and toilets, poor provision of educational resources such as textbooks, a shortage of classrooms resulting in overcrowding, poor quality of teachers, a shortage of mathematics and science teachers and the learners themselves.

[11] South Africa's schools are divided into 5 categories named 'quintiles'. The quintiles are determined according to their poverty ranking. The poorest schools are ranked in quintile 1 and the wealthiest schools are ranked in quintile 5 (Hall & Giese, 2008).

2.4.2.3.1 Lack of facilities

Poor facilities in most schools, but especially rural areas, is commonly cited as a factor contributing towards the poor performance of learners (Hugo, Jack, Wedekind & Wilson, 2010). Many rural schools in South Africa endure what can only be described as appalling circumstances. Water and electricity supply are a major concern and libraries and computer laboratories are virtually non-existent (Gardiner, 2008).

Examples of the state of disrepair in rural schools abound. Wenani Ngxabani, governing body chairman of the Samson Senior Primary School in Lebode, Eastern Cape, says that their school is at the bottom of the province's list for structural upgrades and desks and chairs. The school consists of six mud structures and the closest tap is 5km away. *"The lack of water affects the learners as they are often extremely thirsty and lose concentration easily,"* he says (IOL News[c], 2012). In Limpopo over 200 000 learners do not have desks or chairs and toilets are also a problem, with the Lehlaba Primary School in Tzaneen, Limpopo, only having one pit latrine for 90 learners (IOL News[f], 2013). Hundreds of school buildings have poor physical infrastructures which are not conducive to learning. Many are dilapidated, dangerous and unfit for human habitation, see Photo 1.



**Photo 1:** Poor infrastructure at Menziwa High School in the Eastern Cape. (Mail & Guardian[a], 2012).

2.4.2.3.2 Poor educational resources

The problem regarding unequal distribution of resources is still commonplace. Text books are considered significant resources for learners reading and writing development, yet four months into the 2013 school year, 54% of schools across the country had still not received all the textbooks that they ordered, with Grade 11 textbooks for physical science, mathematics, accounting and languages in Limpopo still unaccounted for (IOL News[g], 2013). Even though the majority of schools do receive their text books in time, fewer than half of South African schools allow the learners to receive their own copies of mathematics and literature text books to take home (Strauss, 2006). The SACMEQ III[12] project shows the availability of textbooks for reading and mathematics to South African learners according to Quintiles, see Table 2.1 (Department of Basic Education[e], 2010).

**Table 2.1:** Textbook Availability

| Reading Textbooks | | | | | | |
|---|---|---|---|---|---|---|
| **Quintile** | **No Textbooks** | **Only Teacher** | **Share with 2+** | **Share with 1** | **Own Textbook** | **Total** |
| 1 | 6.8% | 8.1% | 21.9% | 27.7% | 35.6% | 100% |
| 2 | 4.0% | 7.5% | 20.0% | 31.1% | 37.3% | 100% |
| 3 | 3.5% | 5.5% | 16.8% | 30.7% | 43.4% | 100% |
| 4 | 2.9% | 5.4% | 14.6% | 27.7% | 49.4% | 100% |
| 5 | 3.6% | 5.4% | 6.3% | 23.8% | 60.8% | 100% |
| **TOTAL** | **4.2%** | **6.4%** | **16.2%** | **28.2%** | **45.0%** | **100%** |
| **Mathematics Textbooks** | | | | | | |
| **Quintile** | **No Textbooks** | **Only Teacher** | **Share with 2+** | **Share with 1** | **Own Textbook** | **Total** |
| 1 | 13.9% | 16.5% | 16.0% | 24.2% | 29.4% | 100% |
| 2 | 10.2% | 17.9% | 14.8% | 26.0% | 31.2% | 100% |
| 3 | 11.0% | 17.9% | 12.6% | 24.6% | 33.9% | 100% |
| 4 | 10.0% | 17.9% | 9.1% | 23.8% | 39.1% | 100% |
| 5 | 7.4% | 16.6% | 5.7% | 20.4% | 49.9% | 100% |
| **TOTAL** | **10.6%** | **17.3%** | **11.8%** | **23.9%** | **36.4%** | **100%** |

[12] SACMEQIII (Southern and Eastern African Consortium for Monitoring Education Quality) project conducted in 15 countries; namely Botswana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania (Mainland), Tanzania (Zanzibar), Uganda, Zambia and Zimbabwe in 2007.

Not allowing learners to take textbooks and readers home obstructs learning, especially in rural schools where this practice is most prevalent (Taylor, 2008).

#### 2.4.2.3.3 Overcrowded classrooms

Over 4 500 schools, mainly in rural areas, closed their doors between 2007 and 2012 due to students underperformance (IOL News[h], 2012). This existing inequality has created a situation in which students are catching buses from rural disadvantaged schools to advantaged urban schools (Sedibe, 2011). These schools for the most part end up having larger classrooms resulting in overcrowding.

Overcrowding has a negative impact on teaching and learning as learners do not get to engage one-on-one with their teachers. Learners who are struggling with certain concepts get lost in the system. Many teachers who work in overcrowded classrooms have low morale and self-esteem. Large classrooms are also not conducive to dynamic teaching strategies (Rios, 1998). The South African Government stipulates that there should be no more than 35 learners to a classroom (Department of Basic Education[L], 2013: 55). At the Ntapane Junior Secondary School, a rural school in the Eastern Cape, where learners mostly come from families who survive on government social grants, 130 learners can be found in one of the grade nine classes, sitting three or four to a desk, see Photo 2 (The Guardian, 2013).

**Photo 2:** Overcrowding at the Ntapane Junior Secondary School (The Guardian, 2013; Photograph: Sydelle Willow Smith)

Research has shown that smaller classrooms result in an overall improvement in reading and mathematics especially in the earlier grades. Small classes are especially beneficial to learners from low socio-economic families and those whose first language is not English. Overcrowded classrooms are associated with lower student performance which is supported by reading and mathematics competency tests (Howie, 2003; Howie *et al*, 2009).

2.4.2.3.4 Qualifications of teachers

Learners from poor socio economic backgrounds get very little support from their parents and even less intellectual stimulation from their environment, therefore, a learners learning is heavily dependent on what their teacher teaches them in the classroom (Taylor, 2008). As there is a strong correlation between a teacher's qualifications and student performance, (Hugo *et al*, 2010), teacher knowledge is regularly tested as a means of assessing developmental needs and measuring the effect of better quality teacher interventions (Hugo *et al*, 2010). SACMEQ III conducted both a language and mathematics test in 2007 to determine the quality of teaching and learning in 40 schools in KwaZulu Natal.

The language test results taken by teachers, revealed that teachers did well on straightforward questions that required simple information retrieval (75.1%). However, when higher order cognitive thinking was required, their scores dropped significantly and they scored 36.6% for interpretation, 39.7% for evaluation and 55.2% for inference (NEEDU, 2013). Teachers did not fare much better in the mathematics test and achieved: arithmetic operations (67.2%), fractions, ratio and proportion (49.7%) and algebraic logic (46.5%) (NEEDU, 2013). No teacher achieved 100% for a test on the curriculum for which they taught.

The Times newspaper recently reported that a national evaluation on how teachers taught Grade 1 – 3 learners, showed that the teaching was of a poor standard and that their reading ability was weak (IOL News[b], 2013). It is said that approximately 9% of South African teachers are either unqualified or under-qualified (Department of Education, 2005) meaning learners are possibly not taught how to problem solve, think for themselves or do independent reading because most of their teachers do not know how to teach these skills. The newly appointed Head of the National Education Evaluation and Development Unit (NEEDU, 2013), Nick Taylor, says that *"teachers poor subject knowledge is arguably the fundamental problem in the South African school system"* (IOL News[b], 2013).



Additionally, there is a high absenteeism rate amongst teachers (Modisaotsile, 2012) especially in the poorest quintiles in South Africa (Taylor, 2008). Centre for Development and Enterprise (CDE) Executive Director, Anne Bernstein, agrees that teachers do not spend enough time in the classroom and when they do they are not active. She agrees that teachers are often late for class, leave early and only spend 46% of their week teaching (IOL News[i], 2011). Statistics reveal that teacher absenteeism is significant to learner performance and is substantially higher in South Africa than for any other country (Taylor, 2008). Teachers who are regularly late and absent not only form a poor learning environment but also lull a learner into adopting apathetic learning habits and a passive outlook towards their own future (Taylor, 2008).

#### 2.4.2.3.5 Shortage of mathematics and science teachers

The CDE recently reported that not enough teachers are graduating in South Africa, especially in the subjects of mathematics and science. The Department of Basic Education confirms that South Africa had a shortage of 2 888 mathematics teachers and 2 669 science teachers nationally in 2012 (Daily News, 2012). The teaching system is producing only a third of South Africa's requirement of about 25 000 new teachers a year (IOL News[i], 2011) and only a few students graduate in mathematics and science. The challenge for the Department of Education is emanated from teachers' low salaries and poor working conditions which are identified as strategic areas in need of improvement in order to recruit new and retain experienced teachers in the profession (Nilsson, 2003). Currently the Department of Basic Education has a bursary scheme in place, offering a four year bursary to students studying a bachelor's degree in education, specifically targeting mathematics and other scarce skills educators (Jacobs, 2013).

#### 2.4.2.4 Benchmarking learner performance



South Africa takes part in four cross-country comparative studies (Howie *et al*, 2008) namely:

- Trends in Mathematics and Science Studies (TIMMS) – Grade 8 Mathematics and Science;
- Progress in International Reading Literacy (PIRLS) – Grade 4 and 5 Reading;
- Southern and Eastern Africa Consortium for Monitoring Education Quality (SACMEQ) – Grade 6 Reading and Mathematics.
- Annual National Assessment (ANA) – Grade 1 to 6 and Grade 9 Literacy and Numeracy.

The Trends in International Mathematics and Science Study (TIMSS) is an international standardised test for mathematics and science. This test is administered every four years and is intended for Grade 8 learners.

However, in 2011 it was decided that the tests were too difficult for South African Grade 8 learners and instead Grade 9 learners took the tests. Out of 42 countries, South Africa, Botswana and Honduras were the only three countries that tested Grade 9 learners (Spaull, 2013). Despite administering the test to a higher grade, South Africa still scored the lowest on the TIMSS tests among middle-income countries (ENCA, 2014).

South Africa participated in the PIRLS in 2011 which was conducted in 49 countries with over 325 000 participants. The focus was twofold. Firstly, to determine reading for literary experience and secondly, to determine reading for use of information. The target population was Grade 4 pupils around the world. Findings showed that South African Grade 4 learners, specifically black learners whose first language is not English, achieved well below their international counterparts. Only 6% of learners were able to read at an advanced level (Howie, van Staden, Tshele, Dowse & Zimmerman, 2012).



The SACMEQ III scores reveal that South Africa ranks 13th out of 15 in the performance of rural learners for reading and 12th out of 15 in the performance of rural learners for mathematics (Department of Basic Education[e], 2010). According to Spaull (2010), this means that a ‘poor’ South African student performs worse in reading than the average ‘poor’ Malawian or Mozambiquan student who come from much poorer countries. Generally poverty is strongly associated with performance; however, the SACMEQ III scores demonstrate that schools with far fewer resources than South Africa are outperforming South Africa.

In September 2013, the Department of Basic Education conducted the Annual National Assessment (ANA), of learner achievement in the key foundational skills of literacy and numeracy at the level of Grades 1–6 and Grade 9. The results revealed that only 2% of learners in Grade 9 are achieving at least 50% in their mathematics mark.

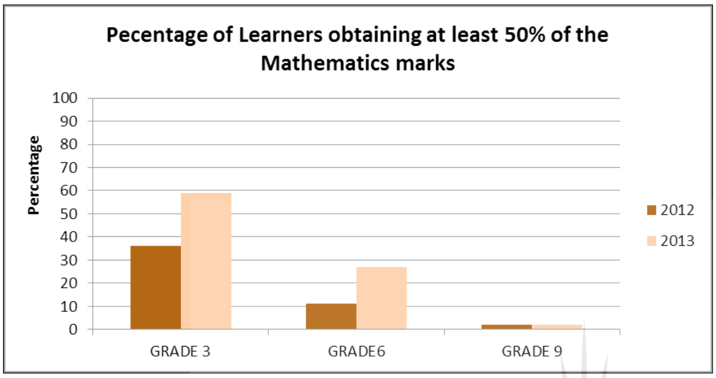



**Figure 2.2:** Learners with acceptable achievement in Mathematics in 2012 and 2013 (Source: Department of Basic Education[f]: 33).

Figure 2.2 shows that our country is in a crisis *"given the strategic importance of Mathematics for a world that has a technological slant and the critical transition that Grade 9 provides into Further Education and Training (FET)"*, interventions to improve the quality of teaching and learning in Mathematics in the senior phase should be made a national priority (Department of Basic Education[f], 2013: 82).

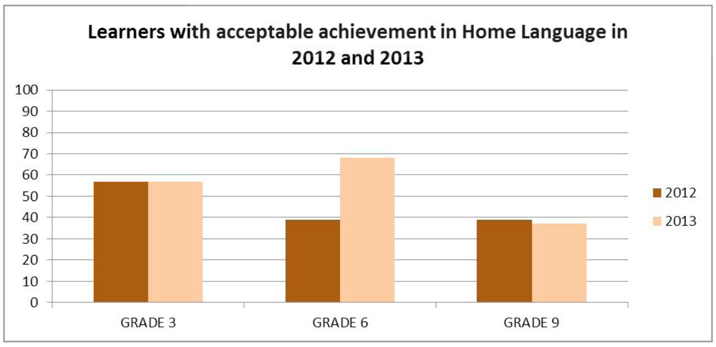



**Figure 2.3:** Learners with acceptable achievement in Home Language in 2012 and 2013 (Source: Department of Basic Education[f]: 34).

Figure 2.3 shows that the percentage of learners reaching acceptable achievement in Grade 9 literacy remains constant, however, it is still well below the goal of 60% set for 2014 (Department of Basic Education[f], 2013).

The ANA report highlights the challenges that the rural provinces like Limpopo, Eastern Cape and KwaZulu-Natal experience in the quality of their teaching and learning which is reflected in the students low levels of performance (Department of Basic Education[f], 2013).

TIMMS, PIRLS, SACMEQ and ANA shows that irrespective of which subject or grade one chooses to test, most South African learners are performing significantly below the curriculum, often failing to acquire basic numeracy and literacy skills. These tests also show that South Africa performs poorly compared too many of its impoverished neighbours and developing countries in other parts of the world.

2.4.2.5 Grade 12 assessments

In South Africa, learners in their last three years of schooling (Grade 10 – 12) have to take seven subjects. Four of these subjects are mandatory: English (either as a first or second language), a second approved language (again, either as a first or second language), Life Orientation and either Mathematics or Mathematical Literacy. Additionally, learners must select three other subjects from a host of disciplines. These include subjects like Geography, Physical Sciences, Life Sciences, Agricultural Sciences, History, Accounting, Business Studies, Economics, etc. (Department of Basic Education[d], 2015).

At the end of the academic year, Grade 12 learners write national examinations in all of their subjects. These national examination papers are set by the Department of Basic Education (DBE). The examination scripts (or other assessment artefacts like art work) are marked and moderated by independent panels of markers, who are teachers who need to apply and meet certain criteria, before being appointed as a marker. The final marks that are achieved for each subject are expressed as a percentage. The final marks for each subject constitute a combination of marks earned during the school year, and the marks achieved during the national examinations. The marks of six subjects (Life Orientation is excluded) are used to calculate an 'Admission Point Score' (APS), as is seen in Table 2.2 (IEB, 2015).

**Table 2.2:** National Senior Certificate achievement levels

| % | 100-80 | 79-70 | 69-60 | 59-50 | 49-40 | 39-30 | 29-20 | 19-10 | 9-0 |
|---|---|---|---|---|---|---|---|---|---|
| **NSC** | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 1 | 1 |
| **Symbol** | A | B | C | D | E | F | G | H | I |

Source: Adapted from Schoer *et al*. (2010)

2.4.2.6 National Senior Certificate

Minimum APS scores are required for admittance to particular programmes, and may differ between institutions (Hunt, Rankin, Schoer, Nthuli & Sebastiao, 2009; Maree, Fletcher & Sommerville, 2011; Nel & Kistner, 2009). Programmes that are considered to be difficult to be successful in, may require higher APS scores than programmes that are considered easier. For example, admission to humanities programmes may require an APS score of 30, whereas admission to engineering programmes may require a higher APS score of 35 (University of Pretoria, 2015). In addition, a sub-minimum mark in specific school subjects may be required before admission to certain programmes is considered. However, in 2014 only 28.3% of learners achieved a bachelor's degree pass[13] (university pass).

[13] For a bachelor's degree pass, a candidate is required to attain 30% in the language of learning and teaching of the Higher Education Institute and more than 50% in four of the following subjects: Accounting, Information Technology, Agricultural Science, Languages, Business Studies, Life Sciences, Consumer Studies, Mathematics, Mathematics Literacy, Dramatic Arts, Economics, Music, Engineering, Graphics and "Design, Physical Science, Geography, Religion Studies, Visual Arts and History (Department of Basic Education[d], 2015).

Van der Westhuizen and Barlow-Jones (2015) (See Appendix J) indicated that universities are reluctant to use the APS score to determine whether, and to which programmes, prospective students may be admitted as the APS score is not deemed to be an accurate measure for admission to higher education programmes (Hunt *et al*, 2009) for a number of reasons. The validity of Grade 12 final examination results are being questioned nationally by the public, educational experts and by universities.

The marks of students who come from 'disadvantaged' schools (Jenkings, 2004 and Marnewick, 2012) are particularly questioned for a number of reasons. Firstly, it is believed that matriculation results are politically manipulated to show an improved performance of the school education system overall, and especially so since democratisation in 1994. Secondly, the marks achieved by learners undergo a process of standardisation by Umalusi, the Council for Quality Assurance in General and Further Education and Training after a process of a review of the marks in order "*to mitigate fluctuations in learner performance that are a result of factors within the examination process itself.*" Therefore, marks may be adjusted upwards or downwards by as much as 10% in any subject that was written during the national examination to align with historical performance trends in the particular subject (Parliament.gov.za, 2014: 1). Thirdly, reports in the local press indicate rife large-scale cheating during the examinations by learners. Approximately 5300 learners were investigated for irregularities during the 2014 National Senior Certificate (NSC) examinations (SAnews, 2015). Umalusi's moderation processes identified "group copying" in maths, economics and business studies. It was also found that there had been "evidence of possible assistance by an invigilator or exams official" in the mathematics paper, which was written by 174 candidates (Times Live, 2015). Finally, according to the South African Democratic Teachers Union (SADTU), "*Schools are manipulating the learner promotion and progress because of pressure to produce better Senior Certificate results*" (2015). It has been reported that schools manipulate marks, or alternatively, that the progression of learners through the grades are artificially managed by holding learners back in some grades and advancing them through others.

Annually, the examination results are published in local newspapers, and learners may on the same day collect their official results and certificates from their former schools. Typically, a news conference is called by the ministry, and the official "matric pass rate" is made known. The official pass rate that has steadily been rising over the past number of years, warrants further scrutiny, according to van der Westhuizen (2013).

He points out that the 'Class of 2012' had a published pass rate of 73.9%. However, this number disregards the 620 000 learners who have dropped out of the educational system since 2001, the year that this cohort of students entered formal schooling. Therefore, the success rate of the cohort is a more sobering 37%. This alternative perspective on the pass rate raises further questions on the quality of South African school education.

2.4.2.7 National Benchmark Test

In addition to minimum grades required in each subject, South African universities either set their own entrance test or use the National Benchmark Tests (NBT's). *"The National Benchmark Tests (NBT's) were commissioned by Higher Education South Africa (HESA) with the task of assessing academic readiness of first year university students as a supplement to secondary school reports on learning achieved in content specific courses"* (NBT, 2013).

The NBT's assess competency in Academic Literacy (AL), Quantitative Literacy (QL) and Mathematics (MAT) that have a direct impact on first year university students' likelihood of success (Marnewick, 2012). The results of the NBT's inform universities about the level of academic support that students may need to be successful in their chosen field of study. The results are also used by universities for program planning. Most universities now require prospective students to write the NBT examination, and will admit students to their programmes based on the scores obtained in those examinations. It is however, recommended, but not compulsory, that prospective students write the NBT's at either the JCU or PCU where this study was conducted.

### 2.4.3 Performance in school mathematics

Several studies have shown a positive relationship between performance in mathematics and computer programming performance, e.g. Byrne & Lyons, 2001; Wilson & Shrock, 2001; Gomes & Mendes, 2008; Bergin & Reilly, 2005.

#### 2.4.3.1 Mathematics

The school subject Mathematics is an academic subject which focuses on abstract, deductive discipline that is required in the scientific, technological, engineering and maths world (STEM) (Venkat, 2007). Bohlmann and Pretorius (2008: 43) claim, "*the conceptual complexity and problem-solving nature of mathematics make extensive demands on the reasoning, interpretive and strategic skills of learners*" which are needed for computer programming.



#### 2.4.3.2 Mathematical literacy

On the other hand, mathematical literacy equips and sensitises learners with an understanding of the relevance of mathematics in real-life situations (Department of Basic Education, 2011[9]). Typical lessons in mathematical literacy could include how to calculate income tax, how to calculate the cost of buying a house, including calculating transfer fees, legal fees and bond repayment amounts. Mathematical literacy creates a consciousness about the role of mathematics in the modern world and is therefore driven by practical applications. The subject develops the ability and confidence of learners to think numerically in order to interpret daily situations (Department of Basic Education[g], 2011).

#### 2.4.3.3 Mathematics vs mathematical literacy

Learners who take mathematics use a wider range of thinking styles than students who take mathematical literacy due to the nature of the cognitive level of the content (Zhang, 2002: 179). Mathematical literacy uses everyday language for *“practical relevance and applications”* which is easier for learners to understand than mathematics which uses an advanced technical language for *“mathematics learning”* (Graven & Venkat, 2007: 69).

#### 2.4.3.4 Mathematics/ Mathematical literacy as a selection criteria

Selection criteria for an IT diploma or degree is usually based on high school mathematics results, as a common belief is that a student who does well in high school mathematics will also do well in computer science (Goold & Rimmer, 2000; Spark, 2005). For admission to the National Diploma: Business Information Technology (NDBIT) at the JCU a student must comply with an APS score of 24 with a minimum mark of 40% in mathematics or 26 with a minimum mark of 70% in mathematical literacy. For admission to the National Diploma: Information Technology (NDIT) at the PCU a student must comply with an APS score of 18 with a minimum mark of 50% in mathematics. Table 2.3 and Table 2.4 below show learners performance in Grade 12 mathematical literacy and Grade 12 mathematics nationally over the last four years.

**Table 2.3:** Learners Performance in Grade 12 Mathematical Literacy for 2011 - 2014 (Department of Basic Education[h], 2011; Department of Basic Education[i], 2012; Department of Basic Education[j], 2012; Department of Basic Education[k], 2013)

| Year | Wrote | No. Pass 40-100% | % Pass 40-100% |
|---|---|---|---|
| **2011** | 275 380 | 178 899 | 65% |
| **2012** | 291 341 | 178 788 | 61.4% |
| **2013** | 324 097 | 202 291 | 62.4% |
| **2014** | 312 054 | 185 528 | 59.5% |

**Table 2.4:** Learners Performance in Grade 12 Mathematics for 2011 - 2014 (Department of Basic Education[h], 2011; Department of Basic Education[i], 2012; Department of Basic Education[j], 2012; Department of Basic Education[k], 2013)

| Year | Wrote | No. Pass 40-100% | % Pass 40-100% |
|---|---|---|---|
| **2011** | 224 635 | 67 541 | 30.1% |
| **2012** | 225 874 | 80 716 | 35.7% |
| **2013** | 241 509 | 97 790 | 40.5% |
| **2014** | 225 458 | 79 050 | 35.1% |

It is clear that a smaller proportion of the total learner enrolment in Grade 12 select mathematics as a subject of which the overall percentage of students who pass with 40% and above is approximately 35%. It is easy to understand why the Global Information Technology Report of 2013 ranks South Africa 143 out of 144 countries for mathematics and science education and 140 out of 145 for overall quality of their education system. This is worse than many of the world's poorest nations in mathematics and science. Only Yemen ranks lower (World Economic Forum, 2013).



2.4.3.5 Similarities between mathematics skills and programming skills

Cuoco, Goldenberg and Mark (1996: 378-384) in an effort to determine what mathematical curriculum to teach in high school, identified a list of mental 'habits of mind' that they felt could be applied to many different situations, namely:

- Experimenters: When faced with a mathematical problem, a learner should experiment with it drawing on previous knowledge to help solve the problem;
- Describers: Learners should be able to describe step-by-step how to solve a mathematical problem, get into the habit of writing down their thoughts, and be able to argue that a solution is true or plausible by showing the calculations;
- Tinkerers: Learners should be able to take ideas apart and put them back together again;
- Inventors: Learners can develop rules for a game, algorithms etc;
- Visualizers: Learners should be able to visualise processes, data, relationships, etc;
- Guessers: Learners should start at a possible solution to a problem and work their way backwards;
- Pattern Sniffers: Learners need to be able to identify hidden patterns.

The key for learners was understanding when to use what (Cuoco, Goldenberg & Mark, 1996). These ‘habits of mind’ closely resemble essential skills needed for computer programming, namely: problem solving (experimenters), attention to detail (describers), logical, critical and abstract thinking (tinkerers), planning and organising (visualizers), top-down thinking (guessers), and pattern recognition (pattern sniffers) confirming that mathematics is an important subject for a novice programming student to have (Cuoco *et al*, 1996). The reality however, is that students struggle to make the transition to higher level qualifications that require mathematics knowledge.

More and more students are entering mathematics intensive qualifications, like computer programming, with fewer of the basic mathematical skills essential for success (Hourigan & O’Donoghue, 2007).

Students who enter higher level qualifications lacking basic mathematical knowledge and skills, are generally categorised as either being ‘under-prepared’ or ‘at risk’. ‘Under-prepared’ and ‘at risk’ students demonstrate one or more of the following characteristics:

- large gaps in their knowledge (NCCA, 2005);
- a lack of numerical skills necessary to cope with everyday life (Graham & Provost, 2012);
- inability to use or apply mathematics except in the simplest form (NCCA, 2005);
- inability to make valid judgements and interpretations or to reason mathematically (O’Donoghue, 2000).

The very notion that performance in mathematics at the school level can be correlated with performance in mathematics in HEIs is being re-examined not only in South Africa but world-wide. For example, at the University of Limerick in Ireland, 31% of students who obtained distinctions in mathematics at the Leaving Certificate level, were diagnosed as being ‘at-risk’ in their higher mathematics courses. This points to international discrepancies between students’ school leaving mathematics examination results and mathematics comprehension post-school. This trend has been observed in the United Kingdom, Australia, Ireland and in the United States of America (Hourigan & O’Donoghue, 2007). In South Africa, a study by Maharaj and Gokal (2006) revealed that there was no correlation between students Grade 12 mathematics results and their performance in first year Information Technology courses. Clearly a substantial discord exists between school leaving abilities in mathematics, and expected performance at university level.

### 2.4.4 English language proficiency

In Chapter, 1 three national studies conducted on the relationship between English and success in programming modules were reported on (See 1.2.3.4). All three studies found that there was a positive correlation between English as a first language and performance in programming modules. Similar results were found in other studies (Sheard, Carbone, Markham, Hurst, Casey, & Avram, 2008; Chumra, 1998; Fabros-Tyler, 2014).

Computer programmes are predominately designed based on the English language, and use *"sequences of text including words, numbers and punctuation"* (Veerasamy & Shillabeer, 2014). A programme is used to create a set of commands that tells a computer what to do (Shelly & Vermaat, 2011). Each programming language has its unique set of keywords and grammatical rules (Veerasamy & Sihllabeer, 2014). There are many different programming languages, the most popular being Java, C, C++, Python and C# (IEEE.org, 2015). These languages were developed in English speaking countries (Silicon India News, 2012). C#, Java, and C++ are popular programming languages being taught in first year programming courses globally.

Post-apartheid South Africa recognises 11 official languages. The 2011 South African census survey reports that Zulu is the language spoken by the majority of the population (22.7%), followed by Xhosa (16%), Afrikaans (13.5%), English (9.6%), Northern Sotho (9.1%), Tswana (8.0%.), Sotho (7.6%), Tsonga (4.5%), Swati (2.5%), Venda (2.4%) and Ndebele (2.1%). Each province is dominated by a single language, spoken by more than half the population of that province (SouthAfrica.info[b], 2013, IOLNews[j], 2013).

Despite the official recognition of 11 languages, at the school exit level, examinations can be written in either English or Afrikaans only. Thus, the majority of rural schools language of instruction, is a learner's mother tongue up until the

Grade 4 level, thereafter a change is made to either English or Afrikaans (Spaull, 2013).

The majority of urban schools language of instruction is either English or Afrikaans from Grade R (Taylor & Coetzee, 2013). English schools teach Afrikaans as a 2$^{nd}$ language and an African language (depending on the province) as a 3$^{rd}$ language. Afrikaans schools teach English as a 2$^{nd}$ language and an African language as a 3$^{rd}$ language. Dr Carole Bloch, director at The Project for the Study of Alternative Education in South Africa (PRAESA) at the University of Cape Town, says that in rural schools "*many teachers don't know how to teach English as a subject nor can they speak well enough to be effective role models of the language. It is imperative that the children interact with people who know the language. For kids to learn to read and write they need adult role models and literary role models – this creates motivation and a desire to learn*" (Media Club SA, 2015).

Even though South Africa is known as the "Rainbow Nation" due to its multiple cultures, not only does English dominate instruction in schools but also at universities (Mail & Guardian[b], 2009). It is however, not uncommon for a country to adopt English as the instructional language in HEIs especially in the fields of medicine, science and information technology (Kirkpatrick, 2011; Tan & Lan, 2011). Examples of this can be found in Europe, Asia and Africa (Airey, 2011).

The previous paragraphs highlighted the complexities surrounding language in the South African context. Most likely, learners enrolled for programming modules will not be English first language speakers even though they have been taught and assessed in English for their high school years.

### 2.4.5 Digital literacy

Information and Communication Technology (ICT) is an increasingly large part of our everyday lives and it is not uncommon to see students at a university walking around with smartphones, iPad’s and laptops. These students are assumed to be digitally literate. According to Hague and Payton (2010: 2), digital literacy can be defined as “*having access to a broad range of practices and cultural resources that you are able to apply to digital tools. It is the ability to make and share meaning in different modes and formats; to create, collaborate and communicate effectively and to understand how and when digital technologies can best be used to support these processes*”.

According to Ng (2012), digital literacy has several dimensions to it, namely; technical, cognitive and social. (1) In the technical dimension, people have the technical and operational skills to use technology to either learn or to perform their everyday life tasks (Host’ovecky & Stubna, 2012). A digitally literate individual would be able to operate technologies such as downloading files, installing software etcetera. An example of a technical dimension would be connecting a computer to a printer. (2) The cognitive dimension is associated with the individual’s ability to think critically, which is essential in computer programming. A digitally literate individual would for example be able to evaluate and select appropriate software programs to learn with or to complete a specific task. (3) The social-emotional dimension of digital literacy focuses on individuals who use technology simply to socialize with others through the use of the Internet. They use digital technology to interact/ communicate with other individuals through applications such as Facebook, Skype, MXIT, WhatsApp, Instagram etcetera (Paolini, Fiore, Contursi, & Bramani, 2006). Being digitally literate therefore requires the development of a set of key skills that are technical, cognitive and social-emotional. Ng (2012: 1068) deems that a person who is able to demonstrate the following abilities is said to be digitally literate:

- carry out basic computer-based operations and access resources for everyday use;
- search, identify and assess information effectively for the purposes of research and content learning;

- select and develop competency in the use of the most appropriate technological tools or features to complete tasks, solve problems or create products that best demonstrate new understanding; and
- behave appropriately in online communities and protect oneself from harm in digitally enhanced environments.

  (Ng, 2012:1068)

In the 21st Century, It is assumed that university students are able to demonstrate some level of ICT skills when starting their first year of studies. This, however, may not necessarily be true. Although many high schools in South Africa have integrated the use of ICT's into their teaching and learning, this is not the case in all schools. This means that many South African first year students only gain exposure to computers when they first enrol at a university.

Research on the impact of digital literacy on a students' academic performance will be discussed next.

2.4.5.1 Cell phone usage and academic performance

Lepp, Barkley & Karpinski (2015) at the Kent State University in the USA investigated the relationship between cell phone usage (i.e. calling, texting, gaming, social networking, surfing the Web etc.) amongst undergraduate students and their academic performance. Findings showed that students who used cell phones more frequently, had lower scores than students who used their cell phones less. Previous studies by Levine *et al*, (2007) explain that this could be because the majority of students use their cell phones for leisure purposes rather than academic purposes, and therefore it is more than likely that the cell phone distracts students from learning.

### 2.4.5.2 Laptop usage and academic performance

Researchers at the Washington University in St Louis revealed that the use of laptops can have a positive effect on student attention and learning if used in the correct manner, as a tool for course-related purposes. However, when laptops were used in class for note taking, the students demonstrated a lower level of engagement.

The study found that students are either distracted by the device in class due to engaging in activities such as social networking or gaming, or they become distracted by others doing the same (Washington University, Teaching Center, 2014).

### 2.4.5.3 Social networking and academic performance

A study by Kirschner and Karpinski (2010) at a mid-western university showed a significant negative relationship between Facebook use and academic performance. Facebook users reported lower mean grade point averages and spent fewer hours per week studying on average than students who did not use Facebook (Kirschner & Karpinski, 2010).

### 2.4.5.4 Internet usage and academic performance

Studies show that university students use the Internet for three main purposes, namely: (1) academic research, (2) online socializing and (3) entertainment (Hernández-Ramos, Martínez-Abad, Peñalvo, García & Rodríguez-Conde, 2014). A few studies have looked at the relationship between the amount of time students spend on the Internet and their academic performance (Ellore, Niranjan & Brown, 2014), however, Chen and Tzeng (2010) argue that it is not the amount of time that students spend online that affects their performance but rather what they do online that counts. Therefore if students are using the Internet for research purposes it was found to be associated with better academic performance than students who used the Internet for online socialising and entertainment (Chen and Tzeng, 2010).

There was no literature found on whether digital literacy affects student performance in computer programming.

### 2.4.6 Previous programming experience

Previous knowledge of programming is one of the most frequently mentioned factors that impacts on a programmer's ability to be successful when learning to programme (Kumwenda *et al*, 2006; Rountree *et al*, 2004; Wiedenbeck, 2005; Pedroni, Oriol & Meyer, 2009; Holden & Weeden, 2003; Sheard *et al*, 2008; Hagan & Markham, 2000; Blewett & Achmad, 2005).

2.4.6.1 Students previous programming experience vs performance

The wide range of previous programming experience that first year students bring to an IT qualification can present a challenge to lecturers. Due to the perception that students with previous programming experience have an advantage in an IT qualification, studies conducted at universities across the world to this end will be discussed next.

**Hagan and Markham (Monash University – Australia)**

In a study by Hagan and Markham (2000) at Monash University in Australia, findings of an introductory Computer Science 1 (CS1) course revealed that there is a significant difference between novice and experienced programming students, and that the difference is systematically related to the number of programming languages previously used. Therefore, the more experience with programming languages a student had, the better their ability to learn a new programming language tended to be.

**Kumwenda, Rauchas and Sanders (University of the Witwatersrand – South Africa)**

The School of Computer Science at the University of the Witwatersrand, recognised that first year programming students from more affluent schools had previous programming experience, as opposed to students from schools in poorer areas who had none. To this end a study was conducted to determine whether the students with no programming experience were at a disadvantage. The results showed a statistically significant difference in overall performance between students with prior programming experience and those without, with those students with prior programming experience performing better.

When the results were divided into the categories of Fundamental Algorithmic Concepts (FAC) and Basic Computer Organisation (BCO), there was a significant difference in performance in BCO but not FAC. An investigation revealed that none of the students were familiar with the functional style in which FAC was taught and the students were therefore on an equal footing, whereas the BCO topic covered low level programming in which students with previous experience outperformed their less experienced peers (Kumwenda, Rauchas & Sanders, 2006).



**Holden and Weeden (Rochester Institute of Technology – USA)**

A research study conducted at the Rochester Institute of Technology in New York revealed that a fair amount of students (26%) study an IT qualification with no prior programming experience and very little computer knowledge. Holden and Weeden (2003) introduced a sequence designed to stream students based on their level of prior programming experience. They found that prior programming experience had an impact on student performance in the first part of the sequence but students experience lost its impact on performance in subsequent sequences. They concluded that the difficulty in learning to program is in mastering the basic concepts. Once the basic concepts are learnt the students with no prior experience perform at the same level.

**Ventura and Ramamurthy (University of West Georgia - USA)**

Contrastingly, Ventura and Ramamurthy (2004) found that students with prior programming experience did not perform better than novices in an object-oriented Java taught Computer Science 1 (CS1) course. In an effort to verify their data, it was re-examined. All tests however, failed to reveal any correlation between students' previous programming and CS1 scores. Kumwenda, Rauchas and Sanders explain that this could be due to the students with previous programming experience, initially being taught in a procedural way and the transformation to learning object-oriented programming caused confusion. Novice programming students possibly did better because they had no previous misconceptions (Kumwenda, Rauchas & Sanders, 2006).

2.4.6.2 Programming in South African schools

The various studies above show that prior programming experience is a predictor of performance in first year programming modules, the results however vary based on the different types of modules offered. In the context of this study, the lack of previous programming experience is exacerbated by the dearth of school going learners who opt to select Information Technology as a subject in Grade 10 through to Grade 12 (Koorsse *et al*, 2010) as discussed in Chapter 1.

Havenga and Mentz (2009) from the North West University (NWU) in South Africa, express several concerns about the Grade 12 subject IT. Their main concern is that the exit level expectations of the subject (National Qualifications Forum Level 4) are too high when compared to first and even second year expectations at university level (National Qualifications Forum level 5 and 6) making it extremely difficult for school learners to succeed.

In their investigation into this matter, Havenga and Mentz held meetings with IT teachers' in February 2008 and February 2009.

In addition, informal meetings with teachers during the practical teaching session of student teachers at the North-West University were also held. During these meetings, the teachers raised the following problems that they were experiencing:

- *Teachers themselves experienced difficulty in mastering the subject*; IT was only introduced into South African schools for Grade 10 in 2006. The first Grade 12 exam was written in 2008. A number of teachers did not have sufficient time to be trained in the subject and consequently opted to rather teach Computer Applications Technology (CAT) an easier subject, resulting in some schools terminating IT as a subject.

- *Learners found the subject difficult compared to their other subjects*; high achievers do not want poor performance in IT to affect their overall average, and therefore they do not choose IT as a subject. This is particularly relevant to student's who rely on bursaries as a means to pay their university studies and also students who need a high Admission Points Score (APS) which determines their admission to university studies. A teacher mentioned that three of her student's had dropped the subject at the end of Grade 10 and replaced it with CAT in Grade 11 in order to stay in the top 10 of achievers in their grade (Havenga & Mentz, 2009).

- *Schools were finding it difficult to find well-trained teachers in IT*; over the last three years the North West University has noticed a marked decrease in the number of student teachers enrolling to major in the subject IT. This is confirmed by the Department of Basic Education and Training who report that 1.1% of Further Education and Training (FET) phase students across the country specialised in Information Technology as a subject in 2009.

- *There was not enough time to cover both theoretical and practical outcomes in the curriculum*; currently the National Qualifications Forum (NQF) stipulates that the IT theory and practical component combined should comprise four hours per week. Due to the programming component being weighted at 60%, teachers are spending more time on the practical component than on the theoretical content. This has had a negative impact on the theory examination paper averages which are low.

The subject IT is not an entry requirement for an IT qualification at either the JCU or the PCU in South Africa where the study was conducted.

## 2.5 SUMMARY

Pre-entry attributes, that have been found to be effective predictors of programming performance in other countries, have been discussed in this chapter. These pre-entry attributes will be analysed individually to determine their significance to student academic performance in programming modules in two higher education institutions in South Africa (JCU and PCU).



In the following chapter, the research design used in this study will be discussed in more detail.

# CHAPTER 3

# RESEARCH DESIGN

## 3.1 INTRODUCTION

The purpose of this study is to assess the extent to which the pre-entry attributes that were identified after the literature review, affected first-year student's performance in two programming modules at the Johannesburg City University (JCU), Johannesburg and the Pretoria City University (PCU), Pretoria. In this chapter the procedures used in undertaking the research, the development of the measuring instruments and the methods used to do the statistical analysis of the data are discussed. The first section focuses on the research design, followed by the data collection and data analysis techniques. Reliability and validity, and matters pertaining to the ethical aspects of the study are also discussed.

Figure 3.1 illustrates the research design of the study:

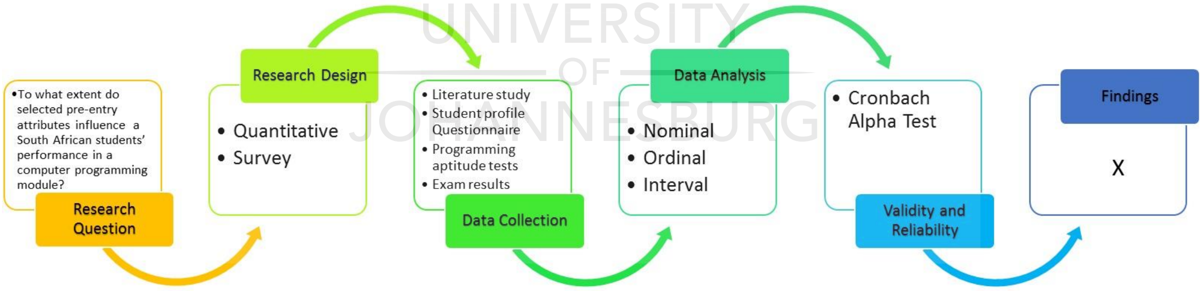



**Figure 3.1:** Schematic representation of the research design

## 3.2 PARADIGMATIC APPROACH

The research design refers to the overall strategy that the researcher chooses to integrate the different elements of the study in a coherent and logical way, thereby, ensuring that the study effectively addresses the research problem. As Kumar (2011: 94) states, "*A research design is a procedural plan that is adopted by the* *researcher to answer questions validly, objectively, accurately and economically".* The research design is therefore a complete plan for the entire research project from the beginning to the end. It outlines the process that was followed from the research question to the data collection and analysis (du Plooy-Cilliers, Davis & Bezuidenhout, 2014).

The research design of this study follows a quantitative research approach in the form of a survey. To gain a better understanding of why and how the researcher chose the methodological approach in this study, an initial discussion will be conducted related to paradigms that may best fit this study. "*Paradigms are patterns of beliefs and practices that regulate inquiry within a discipline by providing lenses, frames and processes through which investigation is accomplished"* (Taylor, Kermode, & Roberts, 2007: 5).

Positivism can be defined as the approach of the natural sciences to study certain phenomena. Positivists identify causal relationships so that they can predict and control the natural and social world. They obtain knowledge through the testing of hypotheses. Positivist researchers must therefore find evidence to either support or reject these hypotheses. "*Positivists assert that by establishing causal relationships and by meeting the conditions of the cause, certain predictions can be made in terms of the effect*" (Du Plooy-Cilliers *et al*, 2014: 93).



A second paradigmatic approach, Interpretivism argues that people "*interpret their environment and themselves in ways that are shaped by the particular cultures in which they live*" (OpenLearn, 2015). Therefore their behaviour is culture orientated. Unlike positivists who seek to predict and control the natural and social world, interpretivists want to understand it. *"Interpretivists believe that truth is dependent on people's interpretation of facts"* (du Plooy-Cilliers *et al*, 2014). Unlike the positivist theory which elicits quantitative data, interpretivist theories rely on qualitative data. Focus groups and interviews are often used in interpretivist research (Quinlan, 2011). See table 3.1.

**Table 3.1:** Paradigmatic views

| Paradigm | Methods (primarily) | Data collection tools (examples) |
|---|---|---|
| **Positivist** | Quantitative. Although qualitative methods can be used within this paradigm, quantitative methods tend to be predominant. | Experiments<br>Tests<br>Surveys |
| **Interpretivist** | Qualitative methods predominate although quantitative methods may also be utilised. | Interviews<br>Observations<br>Document reviews |

Positivist research generates numerical data that are statistically analysed around measures of central tendency in the data. In quantitative analysis the unit of measurement is the variable to which a numerical value is ascribed which represents a response to an item. The variables captured could be either nominal, ordinal or interval (Quinlan, 2011). For example, in order to test a hypothesis, to be sure that A is causing B and nothing else is causing B, the researcher must isolate the variable that they have identified and ensure that no other factors interfere with or influence the outcome. Positivist researchers must therefore find evidence to either support or reject these hypotheses. The paradigm of this study is quantitative.

## 3.3 QUANTITATIVE RESEARCH APPROACH

It has already been stated that "*quantitative methods emphasise objective measurements and numerical analysis of data collected through questionnaires or surveys. Quantitative research focuses on gathering numerical data and generalizing it across groups of people*" (Babbie, 2010). The goal of quantitative research is to determine the relationship between independent variables and a dependent variable in a specified population. Quantitative research can either be descriptive, thereby describing the data gathered or inferential whereby the researcher tries to reach conclusions that extend beyond the data (Quinlan, 2011). Surveys represent one of the most common types of quantitative educational research. For the purposes of this study the researcher will conduct a descriptive and inferential design describing the data and showing the associations between the independent variables and dependent variable.

The key concepts associated with a quantitative research study are to "*classify features, count them and construct statistical models in an attempt to explain what is observed"* (University of Southern California, 2014).

This study is typified as quantitative research because:

**The data was gathered using a structured research instrument** (Field, 2009). The researcher gathered data from a Student Profile Questionnaire (SPQ), a number of computer programming aptitude tests and the final examination score for Development Software 1, as shown in Figure 3.2.

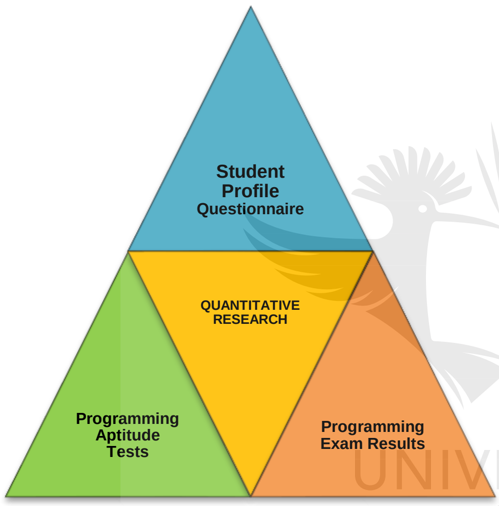



**Figure 3.2:** Data gathering instruments



**The results are based on large sample sizes that are representative of the population** (Quinlan, 2011). The total sample size for the study consisted of 379 students, which is large enough for most statistical procedures to be performed. The population from which the sample was drawn could be considered as the total enrolment of students at the JCU (200) and the PCU (500) studying the National Diploma Business Information Technology and the National Diploma Information Technology respectively.

**The researcher has a clear research question to which objective answers are sought** (Jackson, 2012). The research question "To what extent do selected pre-entry attributes influence students' performance in a computer programming module?" is focussed, concise, complex and arguable which makes for a strong research question according to Quinlan (2011).

**All aspects of the study were carefully designed before the data were collected (**Nardi 2006). The Student Profile Questionnaire (SPQ) was designed after an in-depth literature study was carried out. The SPQ was also subject to measures to establish validity and reliability (see 3.9 and 3.10).

**Data is in the form of numbers and statistics** (Fowler, 2009). The researcher collected data from a Student Profile Questionnaire which produced numerical descriptions about the 379 students studying the National Diploma Business Information Technology and the National Diploma Information Technology at the JCU and the PCU.

**The study can be used to predict future results** (Babbie, 2010). In this study, a number of statistical techniques were used to establish the reliability of the instruments, which infers that these instruments could be used to predict future results. The techniques used were Exploratory Factor Analysis and Cronbach Alpha tests (see 3.10.1 and 3.10.2).



### 3.4 SURVEY METHOD

Survey research is used *"to answer questions that have been raised, to solve problems that have been posed or observed, to assess needs and set goals, to determine whether or not specific objectives have been met, to establish baselines against which future comparisons can be made, to analyse trends across time, and generally, to describe what exists, in what amount, and in what context"* (Isaac & Michael, 1997: 136). Surveys, besides being capable of obtaining information from large samples of the population, are objective and inclusive in the types and number of variables that can be studied (Bell, 1996: 68). Surveys are also well suited to gathering demographic data (age, gender, race, income and so on) that describes the composition of the sample (McIntyre, 1999: 74).

## 3.5 SAMPLING

Annually, the JCU has an intake of 100 students for the National Diploma Business Information Technology and the PCU has an intake of 500 students for the National Diploma Information Technology. Repeaters were excluded from the data set. 186 students from the JCU (2 cohorts 2013/ 2014) and 193 from the PCU were sampled. The total sample size for the study consisted of 379 students (see Figure 3.3).

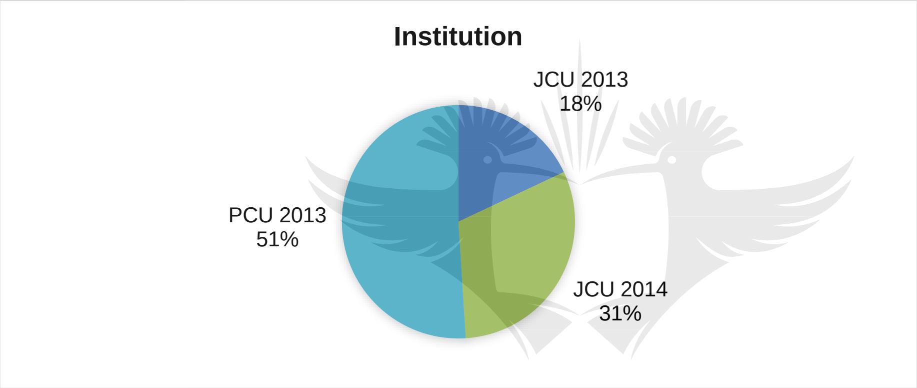



**Figure 3.3:** Sample group



Sampling for this study was based on convenience sampling as the researcher included student's that were accessible to her and formed part of her lecturing classes. 51% of the students were from the PCU and 49% from the JCU.

## 3.6 DEMOGRAPHICS OF RESPONDENTS

The data that were collected during this study yielded the following demographic description of the respondents. In Chapter 2, the notion of social economic status legacies were raised, and the role it may play in success in higher education. The demographic descriptors could therefore be important predictors of academic performance.

### 3.6.1 Race

The ethics committee of the PCU would not allow the capturing of race, as 'race' could be considered as discriminatory. The results in Figure 3.4 are descriptive of the students at the JCU only.

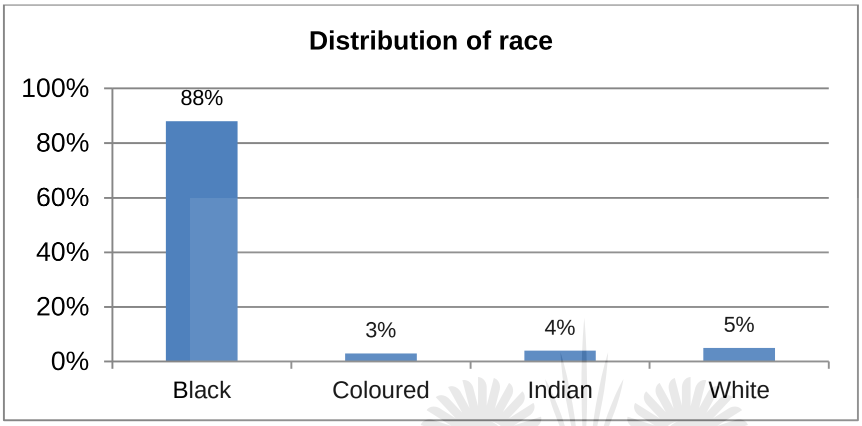



**Figure 3.4:** Racial composition (JCU only)

The majority of students partaking in the study at the JCU were black (88%).

### 3.6.2 Age

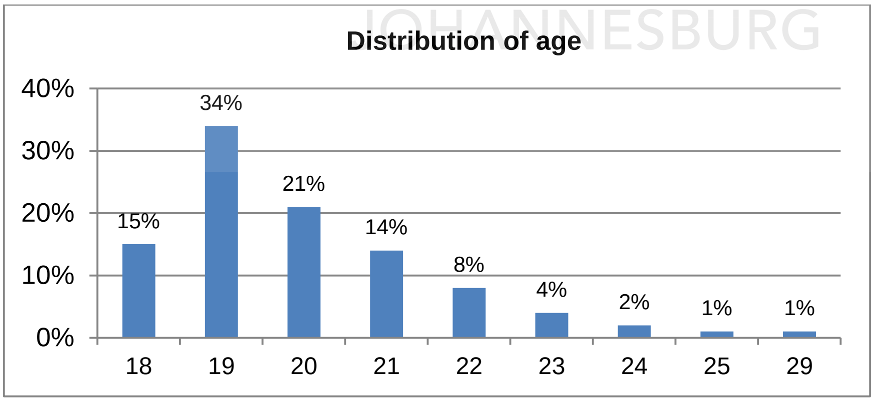



**Figure 3.5:** Age

The majority of students were in the age range of 18 to 21 years of age (84%).

### 3.6.3 Home language

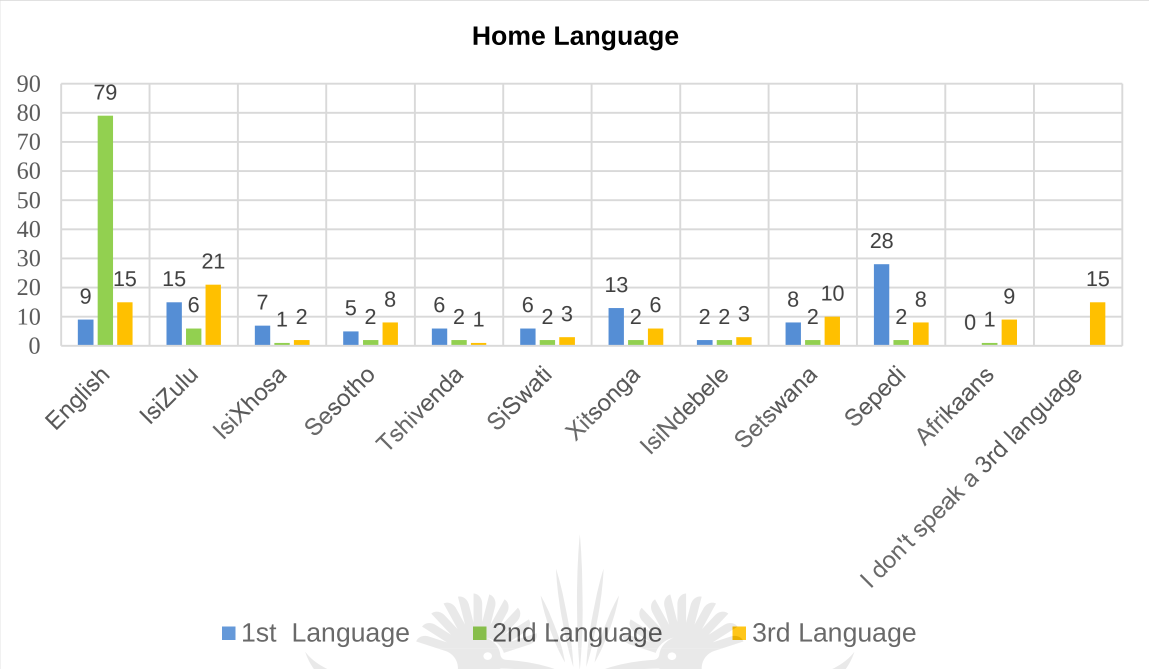



**Figure 3.6:** Language

Figure 3.6 indicates that the majority of the first year students' home language was either Sepedi, isiZulu or Xitsonga, with only 9% of students being English, which is the language of instruction at both universities.



### 3.6.4 Gender

The sample included 66% male students and 34% female students as shown in Figure 3.7.

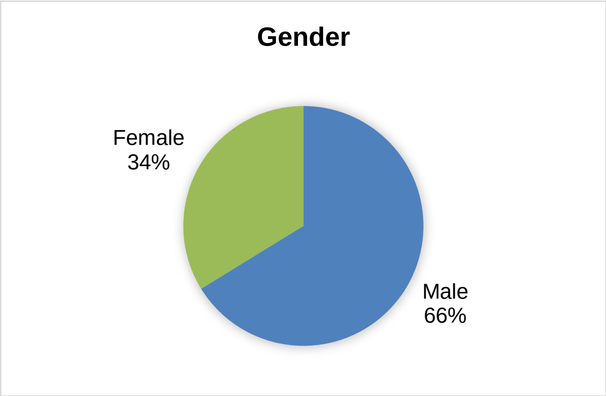



**Figure 3.7:** Gender

It has been reported in many computer education studies (see Hill, Corbett & St. Rose, 2010; Biggers, Brauer & Yilmaz, 2008; Zweben, 2011; Krause, Polycarpou & Hellman, 2012) that female enrolment in computer science is relatively low. The gender distribution in the sample is thus considered as typical of gender distributions relating to programming module enrolment elsewhere in the world.

### 3.6.5 Province of origin

The map of South Africa in Figure 3.8 shows the distribution of provinces where the first year programming students attended school.



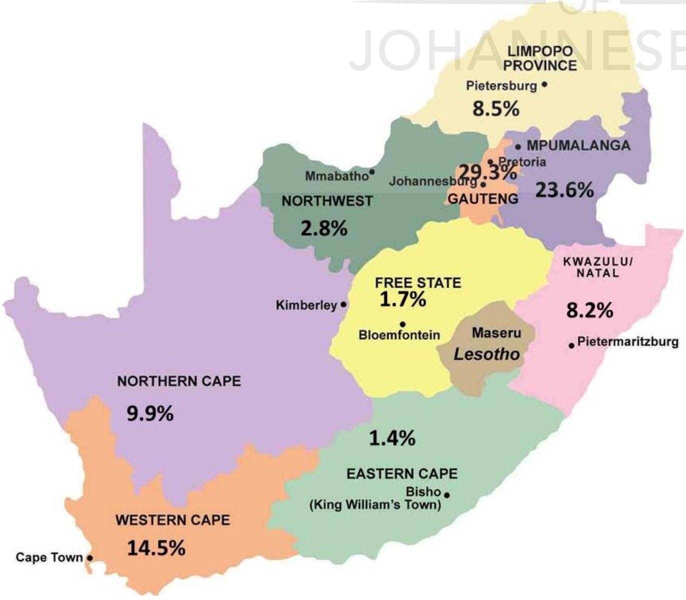



**Figure 3.8:** Province where student was schooled

The majority of students in the sample originated from Gauteng (29.3%) and Mpumalanga (23.6%) and the least number of students came from the Free State (1.7%) and Eastern Cape (1.4%).

### 3.6.6 Socio-economic background of the students

In order to determine the socio-economic background of the students in the sample, they had to respond to the following items in the SPQ. Each item had different response options, as were deemed appropriate:

- How would you describe the immediate environment in which you grew up?
- Which of the following best describes the house in which you grew up?
- What is the highest qualification that your mother/ father or female/ male caregiver holds?
- If your mother/ father or female/ male caregiver is currently employed, what is the nature of their employment?

The subsequent paragraphs and figures give insight into the socio-economic background of the students who participated in the study.

3.6.6.1 The immediate environment in which students grew up

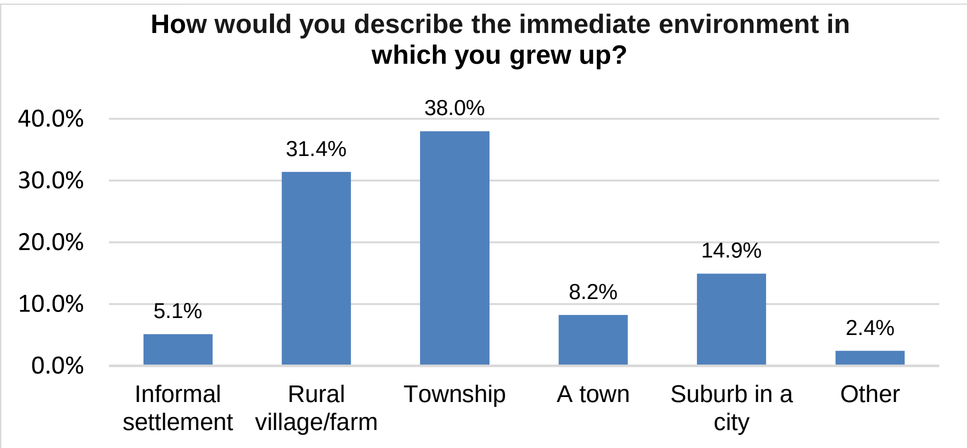



**Figure 3.9:** Environment students grew up in

Figure 3.9 shows that 36.5% of the students were raised in either informal settlements[14] or rural villages. Townships in the South African context were originally built as a way of keeping blacks in a separate area to the whites. Townships were generally located on the periphery of towns and cities and consisted of low-income housing (Pernegger & Godehart, 2007). 38% of the students were from townships. The remaining 23.1% of students were from towns or suburbs in a city.

### 3.6.6.2 The type of house in which students grew up

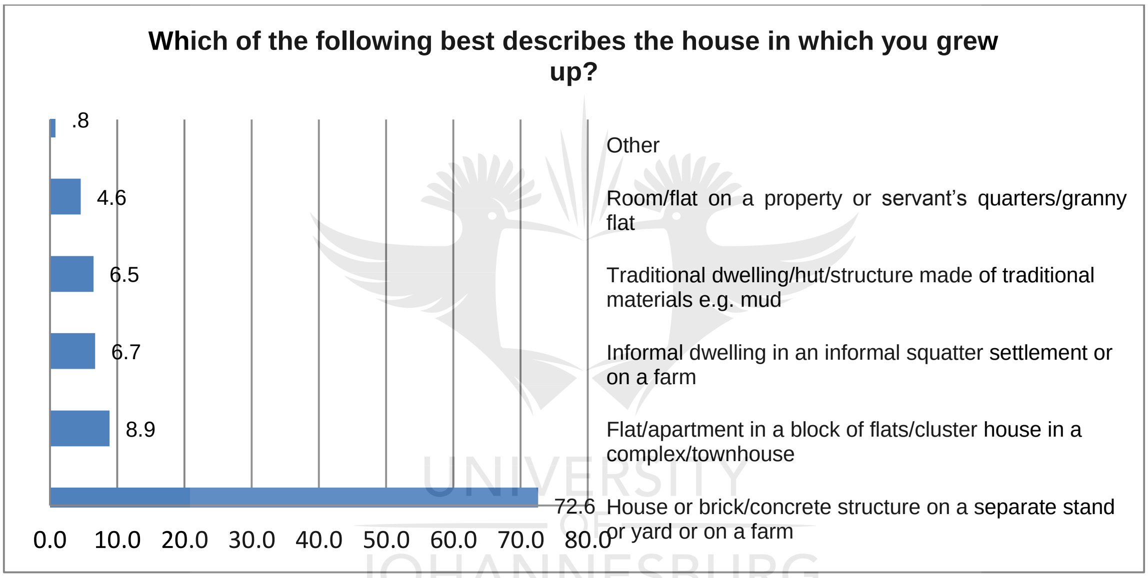



**Figure 3.10:** Type of house in which students grew up

Figure 3.10 shows that 17.8% of the students grew up in either a hut, informal squatter settlement or a room on a property. 81.5% of students grew up in a brick house, townhouse or complex.

[14]An informal settlement can generally be described as a *"few dwellings or thousands of them, that are generally characterised by inadequate infrastructure, poor access to basic services, unsuitable environments, uncontrolled and unhealthy population densities, inadequate dwellings, poor access to health and education facilities and lack of effective administration by the municipality"* (National Department of Human Settlements, 2015).

3.6.6.3 Highest qualification of mother/ father or female/ male caregiver

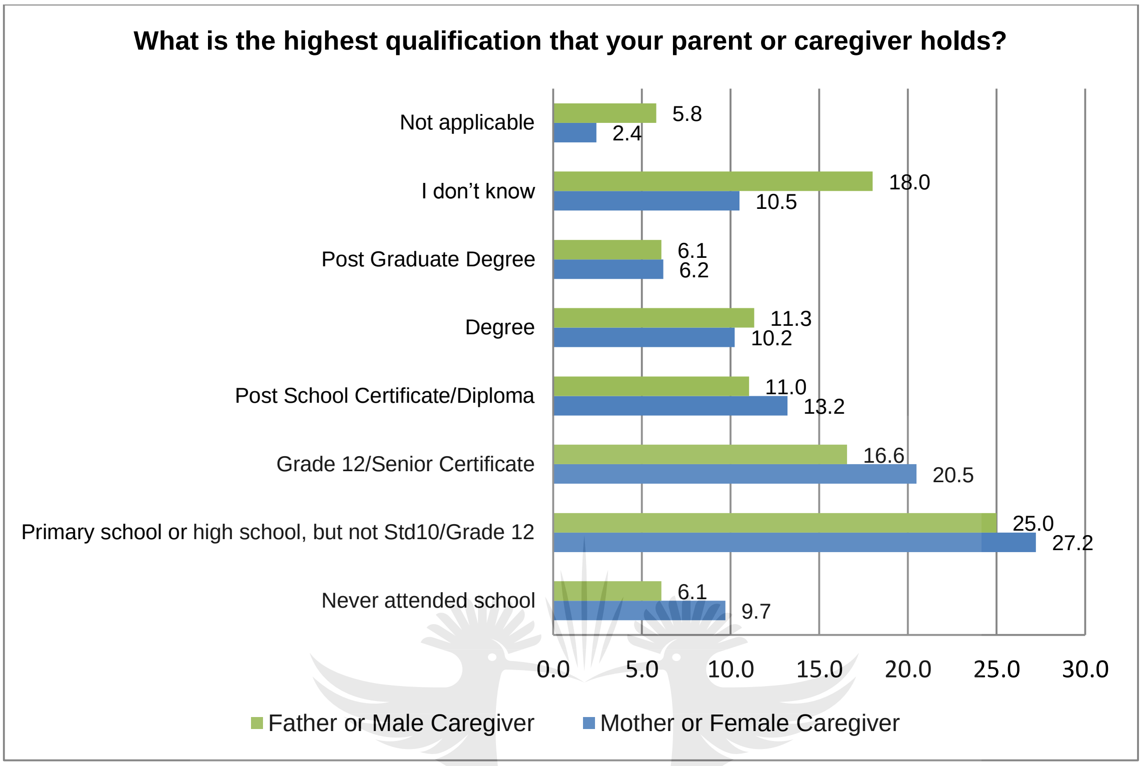



**Figure 3.11:** Parent or caregivers highest qualification

**Mother/ Female Caregiver -** Many students (9.7%) indicated that either their mother or female caregiver never attended school. 27.2% did attend school but never matriculated. Only 29.6% had either a post school certificate/ diploma (13.2%), degree (10.2%) or post graduate degree (6.2%). 10.5% of students' did not know their mother or female caregivers highest qualifications.

**Father/ Male Caregiver -** 6.1% of students indicated that either their father or male caregiver never attended school. 25% did attend school but never matriculated. Only 28.4% had either a post school certificate/ diploma (11%), degree (11.3%) or post graduate degree (6.1%). 18% did not know their father or male caregivers highest qualifications, this could be because most students who come from incomplete families would either live with their mother or grandmother and in some cases not know their father (IOL[k], 2013).

### 3.6.6.4 Parent or caregiver's employment status

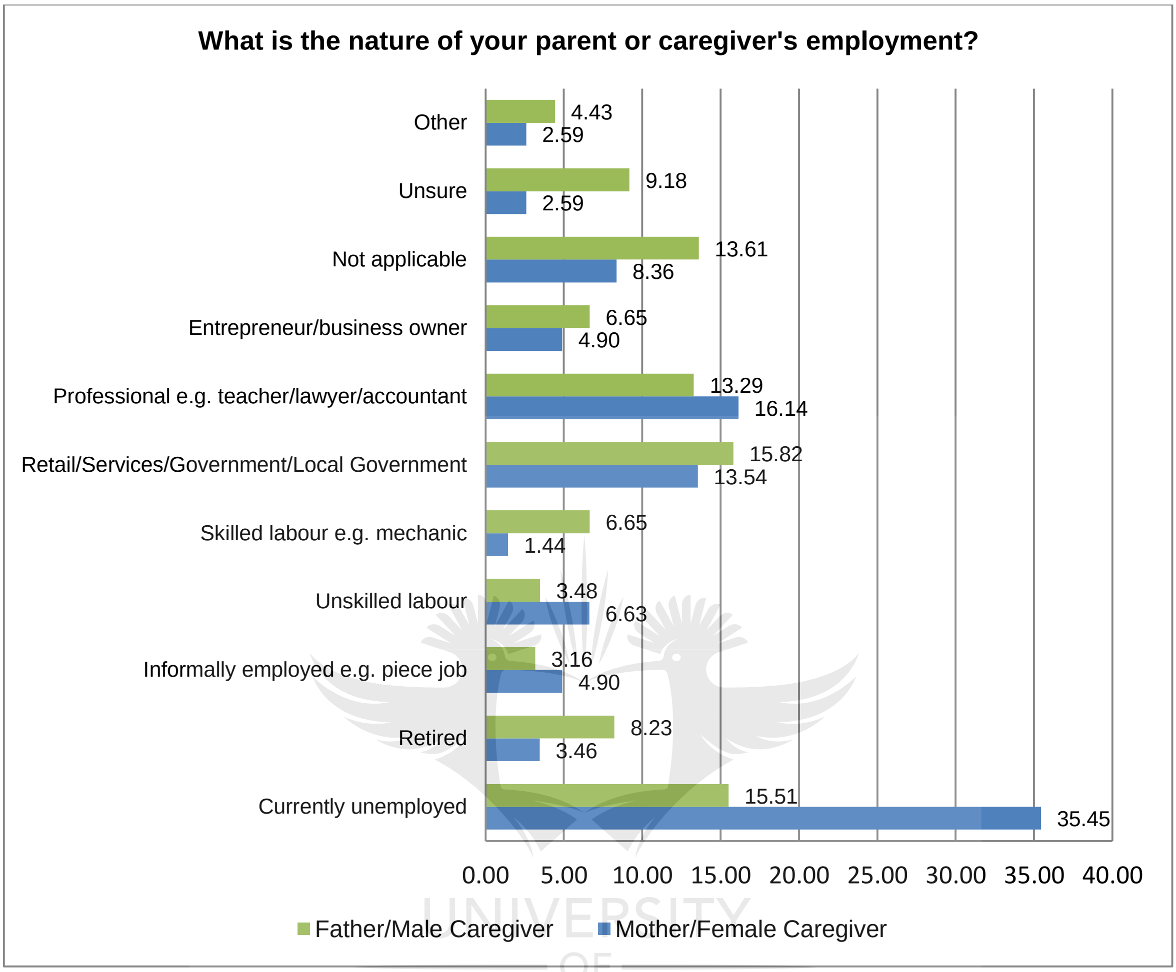



**Figure 3.12:** Parent or caregivers employment status



Thirty five point four percent of students indicated that their mother or female caregiver was unemployed, 3.5% were retired and 4.9% were informally employed. 15.5% of students indicated that their father or male caregiver was unemployed, 8.2% were retired and 3.2% were informally employed. In South Africa, the unemployment rate measures the number of people actively looking for a job. According to the latest reports, South Africa's unemployment rate is 24.3% (Trading Economics.com[a], 2015). The employment status of parents/ caregivers depicted in the sample is thus considered as typical of the employment status in South Africa.

3.6.6.5 Access to electricity and forms of technology

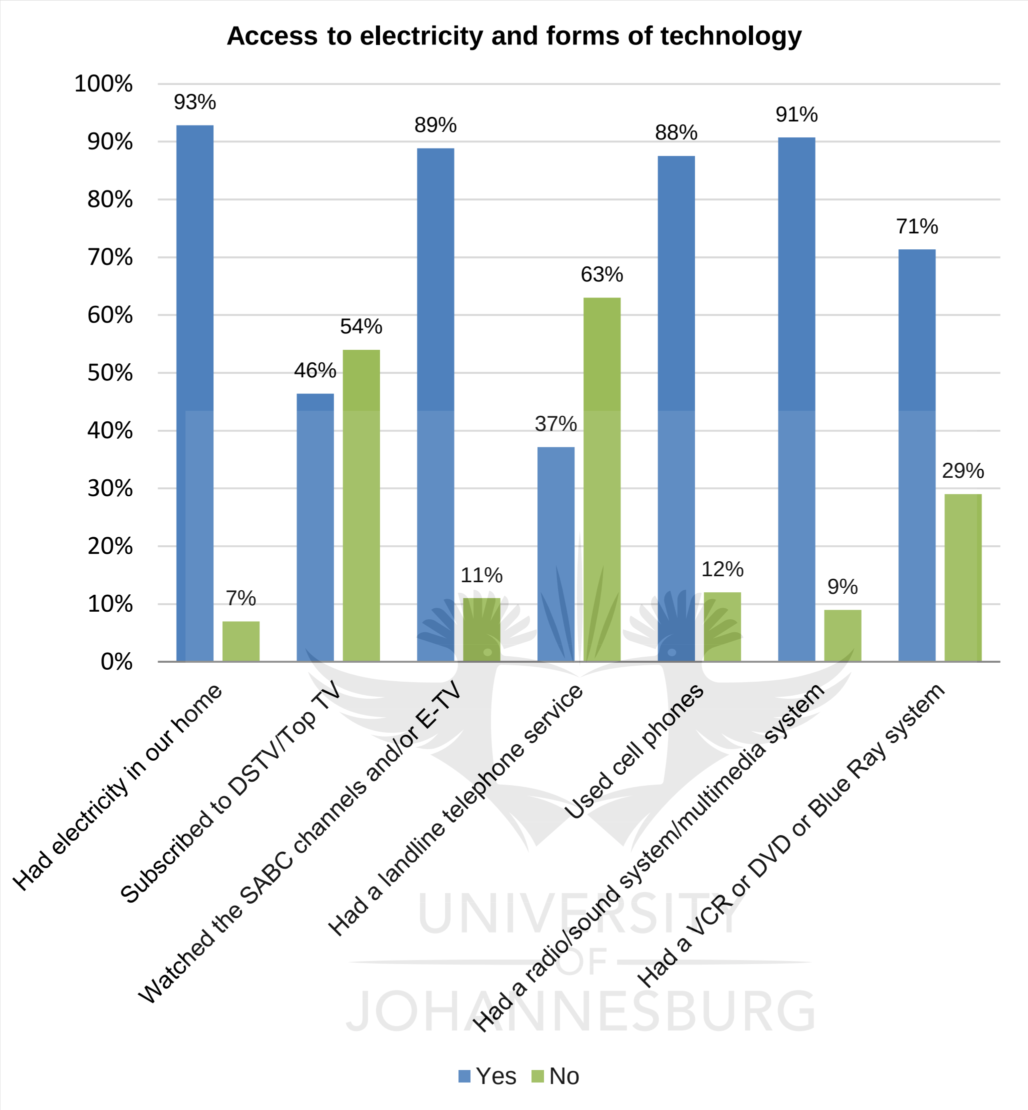



**Figure 3.13:** Access to electricity and forms of technology

Figure 3.13 indicates that the majority of the respondents had access to electricity in their homes (93%) and radio/ sound/ multimedia systems (91%). 88% of students used cell phones. In general the figure shows that the majority of respondents had access to electricity and different forms of technology.

The demographics of the sample is reflective of the population of South Africa as shown in Table 3.2:

**Table 3.2:** Social indicators from the 2011 census survey (Source: Statistics South Africa, 2014)

| Indicator | Black | Coloured | Indian | White | RSA |
|---|---|---|---|---|---|
| No schooling | 10.5% | 4.2% | 2.9% | 0.4% | 8.6% |
| Grade 12/Std 10 and/or Higher Ed. | 35.2% | 32.6% | 61.6% | 76% | 40.7% |
| Informal dwellings | 16.4% | 8.1% | 1.3% | 0.5% | 13.6% |
| Formal dwellings | 72.7% | 90.2% | 97.5% | 98.6% | 77.6% |
| 3 or less rooms in dwelling | 48.1% | 32.1% | 14.1% | 8.5% | 41.8% |
| No access to piped water | 10.9% | 1.5% | 0.8% | 0.7% | 8.8% |
| Flush toilet connected to sewerage system | 48.3% | 85% | 94.7% | 91.2% | 57% |
| Electricity used for lighting | 81.4% | 94% | 98.5% | 99% | 84.7% |
| Electricity used for cooking | 69.8% | 89.9% | 92.1% | 88% | 73.9% |
| Refuse removal by local authority weekly or more | 54.5% | 87.5% | 95.4% | 90.9% | 62.1% |
| Fridge | 62% | 82.5% | 96.7% | 98.2% | 68.4% |
| Cellphone | 88.3% | 83.7% | 92.9% | 96.1% | 88.9% |
| No internet access | 70.6% | 64.3% | 41.7% | 29.6% | 64.8% |
| Unemployment, Q32013 | 28.1% | 24.2% | 10.8% | 6.6% | 24.7% |

Blacks who make up the majority (more than 90%) of the JCU and the PCU's sample group have lower levels of education, are more likely to live in informal dwellings, are less likely to have access to electricity or flushing toilets and less likely to own appliances such as refrigerators than the coloured, indian and white racial groups. Black people are also affected the most by South Africa's high unemployment rate (Statistics SA, 2014). Socio-economic factors are directly linked to the quality of education that is available to learners (Gardiner, 2008).



## 3.7 INSTRUMENTATION

Several instruments were used to collect data from the students. Firstly, a set of four programming aptitude tests (Appendix C, D, E and F) were identified and completed in February 2013 and 2014. The purpose of each of these tests was to determine students problem solving abilities (see 3.7.1). Secondly, a 'Student Profile Questionnaire' (SPQ) (Appendix B) was developed by the researcher. The SPQ was developed as an instrument to gather data from the respondents on the various pre-entry attributes (as independent variables) that were evaluated in this study namely (1) problem solving skills (2) social economic status (3) educational background, (4) performance in school mathematics, (5) performance in school English, (6) digital literacy, and (7) previous programming experience. The SPQ was completed in November 2013 at the JCU and the PCU and in February 2014 for the next intake at the JCU (see 3.7.2). Thirdly, examination results of 2013 and 2014 students were tabulated (see 3.7.3). A detailed discussion of these follows.

### 3.7.1 Programming aptitude tests

In Chapter 2, the competencies required for success in computer programming were described. Thereafter, a battery of tests assessing competencies such as numerical reasoning, non-verbal reasoning, logical reasoning, and verbal logic which are required in technical computing jobs were identified. These tests were used with permission from the University of Kent Careers and Employability Service Department (Appendix I). All tests were completed in a test-like setting with hired venues and appointed invigilators. Ten items from each test were used to reduce the load on students and due to time constraints.

#### 3.7.1.1 Logical reasoning test

The first programming aptitude test was the logical reasoning test (Appendix C) which involved letter sequences and tested the students' ability to think logically and analytically. The test was adapted from the University of Kent's logical reasoning test which consists of 27 questions. This test was condensed into 10 questions and the students had 20 minutes to complete it. The test involved looking at a specific sequence of letters and working out the next letter of the sequence. See the example in Box 1.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Question:

What is the missing letter in this series:

a a b b ? c

Answer:

c

**Box 1:** Numerical reasoning test questions

The average score for the logical reasoning test was 6.7 out of 10, the results will be discussed in Chapter 4.

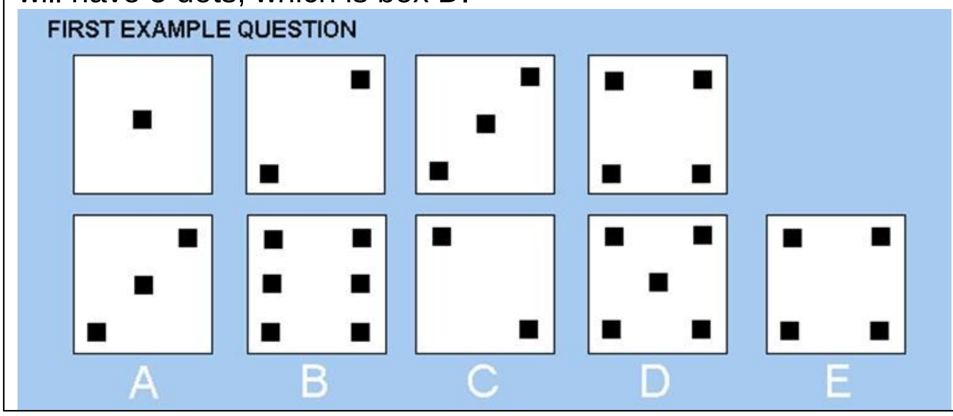
3.7.1.2 Non-verbal reasoning test

The second programming aptitude test was the non-verbal reasoning test (Appendix D) which determined a student's ability to understand and analyse visual information and solve problems using visual reasoning: for example: identifying relationships, similarities and differences between shapes and patterns, recognizing visual sequences and relationships between objects, and remembering these. The non-verbal reasoning test enabled students to analyse and solve complex problems without relying upon or being limited by language skills.

The test was adapted from the University of Kent's non-verbal reasoning test which consists of 20 questions. This test was condensed into 10 questions and the students had 20 minutes to complete it. The test involved looking at a specific sequence and working out the next member of the sequence from the pictures given. See the example in Box 2.



In the first example question the top row of four boxes make up a series from left to right. You have to decide which of the 5 boxes underneath, marked A to E, will be the next in the sequence. For example in the first example, the top four boxes have 1, 2 , 3 , and 4 dots respectively. Obviously, the next box in the sequence will have 5 dots, which is box D.




**Box 2:** Non-verbal reasoning test questions

The average score for the non-verbal reasoning test was 4.65 out of 10, the results will be discussed in Chapter 4.

### 3.7.1.3 Numerical reasoning test

The third programming aptitude test was the numerical reasoning test (Appendix E) which included mathematical questions. The test was adapted from the University of Kent's numerical reasoning test which consists of 27 questions. This test was condensed into 10 questions and the students had 20 minutes to complete it. See the example in Box 3.

Question:

A taxi driver works 46 weeks of the year and gets an average of 70 customers per week averaging 4 kilometers each at 90 cents per kilometer.

His expenditure is as follows:

| | |
|---|---|
| Car service/repair/insurance: | R1,250,00 per year |
| Petrol costs: | R0.06 per kilometer |
| Mortgage costs: | R250,00 per month |
| Other expenditure – food/electricity etc: | R125 per week |

What is the total income in Rands of the taxi driver for the whole year?

Answer:

Average fare = 4 x 90c = R3.60
Income per week = 70 fares at R3.60 each = 70 x 3.60 = R252
Income for 46 weeks work = R252 x 46 = R11,592



**Box 3:** Numerical reasoning test questions

The average score for the numerical reasoning test was 3.24 out of 10, the results will be discussed in Chapter 4.

### 3.7.1.4 Verbal logic test

The fourth programming aptitude test was the verbal logic test (Appendix F) which included verbal logic puzzles, some of which had a numerical element. This test, tested the students' ability to think logically, analytically and numerically, and also to extract meaning from complex information. The test was adapted from the University of Kent's verbal logic test which consisted of 21 questions. This test was condensed into 10 questions and the students had 20 minutes to complete it. See the example in Box 4.

| |
|---|
| Question:<br><br>Simon, Cheryl and Dannii are all going by train to Pretoria to watch a singing competition. Cheryl gets the 2.15 pm train.<br>Simon's train journey takes 50% longer than Dannii's.<br>Simon catches the 3.00 train.<br>Dannii leaves 20 minutes after Cheryl and arrives at 3.25 pm.<br>When will Simon arrive?<br><br>Answer:<br><br>Dannii leaves at 2.35 arrives 3.25 therefore 50m journey<br>Simon's journey takes 75m therefore arrives at 4.15 |

**Box 4:** Verbal logic test questions

The average score for the verbal logic test was 2.79 out of 10, the results will be discussed in Chapter 4.



### 3.7.2 Student Profile Questionnaire

Before developing the survey, the researcher did an extensive literature review on attributes which were believed to impact on a student's ability to learn how to programme (see Chapter 2). The Student Profile Questionnaire (SPQ), attached as Appendix B, was developed as an instrument to gather data from the respondents on the various pre-entry attributes (as independent variables) that were evaluated in this study namely (1) problem solving skills, (2) socio-economic status, (3) educational background, (4) performance in school mathematics, (5) performance in school English, (6) digital literacy and (7) previous programming experience.

The questions contained in the SPQ were mainly based on a review of the international literature enhanced by studying the South African context. The review of the international literature yielded seven pre-entry attributes that have been shown to influence student academic performance in computer programming courses. These seven pre-entry attributes were converted into thirty four questions. These questions were enhanced by uniquely South African factors selected on the basis of local knowledge and personal experience gained working in a South African HEI. During the development of the questionnaire, the researcher attempted to create items to measure the independent variables using Likert-type items.

**Table 3.3:** Variables addressed in the SPQ

| Variable | Example |
|---|---|
| **(1) Problem solving skills** | I try to understand problems before I attempt to solve them. AN = almost never true for me, S = sometimes true for me, HT = true for me about half of the time, O = often true for me, AA = almost always true for me and NA = I cannot respond to the statement/I don't understand the statement. |
| **(2) Socio-economic status** | How would you describe the immediate environment in which you grew up? i. informal settlement, ii. rural village, iii. township, iv. a town, v. suburb in a city, and vi. inner city. |
| **(3) Educational background** | I was encouraged to read a lot to improve my knowledge. The response options for the items ranged from SD = strongly disagree, D = disagree, A = agree, SA = strongly agree, NA = not applicable. |
| **(4) Performance in school mathematics** | Students were asked to indicate their Grade 12 maths mark. |
| **(5) Performance in school English** | My English ability prevents me from performing well academically. The response options for the items ranged from SD = strongly disagree, D = disagree, A = agree, SA = strongly agree, NA = not applicable. |
| **(6) Digital literacy** | An example of an item is "I used the Web to make phone calls e.g. Skype". AN = almost never true for me, S = sometimes true for me, HT = true for me about half of the time, O = often true for me, AA = almost always true for me and NA = I cannot respond to the statement/I don't understand the statement. This section of the questionnaire which consisted of 24 questions was adapted from a survey developed by Kennedy *et al* (2008) from the Lingnan University in Hong Kong. Students were asked to indicate their use of technology and access to technology in order to determine how digitally literate they were. |
| **(7) Previous programming experience** | How much programming experience did you have before enrolling at university? i. I had no programming experience, ii. I had some programming experience, iii. I had quite a bit of programming experience, iv. I had advanced programming experience. |

The SPQ was piloted with five third year tutors who were asked to complete the SPQ and comment on anything that they did not understand. Tutors were also asked whether the questions were pitched at the correct language level. Their feedback was used to make adjustments to the SPQ which was then shared with colleagues for comments.

The questionnaires were completed during the second semester of 2013 at the JCU and the PCU and the first semester of 2014 at the JCU only. The data from the SPQ at the JCU were merged with data from the university's data base to include data about students' Grade 12 English and Mathematics marks as well as demographic data such as their age, gender and race.

### 3.7.3 Development Software 1 exam results

The examination results of the students programming module, Development Software 1: JCU - Development Software 1A (DSW01A1) and Development Software 1B (DSW01B1) and; Tshwane University of Technology - Development Software 1A (DS0171AT) and Development Software 1B (DSO171BT) were included in the data set. Student numbers were used as the key field to link the data sets (SPQ, Programming Aptitude Tests and Development Software 1 Exam Results). The Development Software 1 results were used as the dependent variable throughout the study.

## 3.8 DATA ANALYSIS

The aim of analysis is to understand the various pre-entry attributes of one's data through an inspection of the relationships between concepts, constructs or variables and to see whether there are any patterns or trends that can be identified or isolated, or to establish themes in the data (Mouton, 2001: 108). According to Antonius (2003: 10) *"a variable is a characteristic or quality that is observed, measured, and recorded in a data file"*. Quantitative data can be analyzed using various methods.

The data were analysed using a number of statistical measures: descriptive statistics, Pearson's product-moment correlation coefficient, analysis of variance (ANOVA) and regression analysis. Data were analysed with SPSS version 22 (Statistical Package for Social Sciences).

### 3.8.1 Pearson's product-moment correlation coefficient

The Pearson product-moment correlation coefficient, referred to as Pearson's (r) provided a numerical summary of the direction and the strength of the linear relationship between two variables (which can range from -1 to +1). The P-value provided information on the strength of the relationship (Pallant, 2013). The strength of the relationship was derived from the size of the correlation coefficient. A small coefficient is 0.000-0.290, a moderate coefficient is 0.300-0.4900 and strong coefficient is 0.500 to 0.100. The relationship between variables can also be visually represented by a scatterplot. Scores for Variable 1 were plotted on the X axis and the corresponding scores for Variable 2 were plotted on the Y axis. The scatterplot showed the relationship between the two variables (Pallant, 2013). The Pearson product-moment correlation coefficient measure was computed for each variable to establish the correlation between the independent variables and the dependent variables. These results are reported on in Chapter 4.



### 3.8.2 Analysis of variance (ANOVA)

The ANOVA test was the first step in identifying what factors influenced a particular data set. One-way analysis of variance involved one independent variable (e.g. age group) which had different levels (e.g. ages: 18, 19, 20, 21, 22 etc). The analysis of variance compared the variability in scores between the different groups and the variability within each of the groups – represented by F. The larger the F ratio the more variability there was said to be between the groups than within each group. A significant F score allowed the researcher to reject the null hypothesis (Pallant 2013).

The ANOVA test was computed to put all the data into one number (F) and give one P value for the null hypothesis. These results are reported on in Chapter 4.

### 3.8.3 Regression analysis

Multiple regression analysis answers the question of *“how well a set of variables is able to predict a particular outcome and also which variable in a set of variables is the best predictor of an outcome”* (Pallant, 2013). One of the issues taken into consideration with multiple regression analysis was sample size. According to Pallant (2013) the sample size should be approximately 40 cases per independent variable, in this study this condition has been met. Scatterplots were also analysed for determining the normality of the data, linearity and outliers (Tabachnick & Fidell, 2013).

The regression process tested the ‘goodness of fit’ of the relationship between the independent variable and the dependent variable and how much variation there was by fitting the independent variables into the model. The higher the variability explained, represented by the r-square, the better the model.

After validating the goodness of fit of the regression model, the relevance of each of the independent variables in the model was tested. The p-value for each independent variable was considered at this stage. The lower the p-value (<0.05) the more meaningful the variable was in predicting the Development Software 1 mark for students. The resultant model only consisted of the independent variables with a significant p-value. These results are reported on in Chapter 4.

## 3.9 VALIDITY

Validity refers to the degree to which data accurately reflects or assesses the specific concept that the researcher set out to measure. Several methods were used in this study to establish validity.

According to Fink (2006: 40), in order to help strengthen validity, one should make sure that all relevant topics have been included in the survey. This is referred to as ‘content validity’ and can be defined as *“the extent to which a test measures a representative sample of the subject matter or the behavioral changes under consideration”* (Vockel, 1983: 56). The aim of this study is to find and isolate individual and personal factors of students’ backgrounds that are thought to be attributes of success in their computer programming modules. The validity of using pre-entry attributes to determine students’ academic performance has been established by various authors (see van Zyl, 2010; Oswald, Schmitt, Kim, Ramsay & Gillespie, 2004). The researcher after reviewing the literature developed the student profile questionnaire representing seven variables thought to influence a student’s computer programming mark. Because of the nature of the questions used in the SPQ the researcher, when designing the questionnaire, kept the research question in mind at all times, ensuring that all questions asked were relevant and would measure what they were designed to measure.

Secondly, face validity was used. This instrument was reviewed by the researcher’s supervisor and a statistician at the institution where the study was conducted. After five drafts the supervisor and statistician agreed that the instrument was valid and would measure what it needed to measure. The hypotheses was also mapped with the SPQ as shown in Table 3.4.

**Table 3.4**: Null hypotheses correlation to SPQ questions

| Hypotheses | SPQ Question |
|---|---|
| H01: There is no relationship between a novice South African programming student’s problem solving abilities and their performance in computer programming modules. | Q13 |
| H02: There is no relationship between a novice South African programming student’s socio-economic status and their performance in computer programming modules. | Q3, Q4, Q5, Q6, Q7 |
| H03: There is no relationship between a novice South African programming student’s educational background and their performance in computer programming modules. | Q8, Q12 |
| H04: There is no relationship between a novice South African programming student’s performance in school mathematics and their performance in computer programming modules. | Q32.3 and 32.4 |

| Hypotheses | SPQ Question |
|---|---|
| H05: There is no relationship between a novice South African programming student's performance in English at school level and their performance in computer programming modules. | Q10, Q32.1, 32.2, Q28 |
| H06: There is no relationship between a novice South African programming student's digital literacy and their performance in computer programming modules. | Q19, Q20, Q21, Q23, Q24, |
| H07: There is no relationship between a South African programming student's previous programming experience and their performance in computer programming modules. | Q22 |

## 3.10 RELIABILITY

Reliability is concerned with the accuracy of the actual measuring instrument or procedure; it is "*the extent to which an experiment, test, or any measuring procedure yields the same result on repeated trials*" (Colorado State University, n.d).

Vockel (1983: 29-31) identifies several ways in which to increase reliability:

**Table 3.5:** Ways in which to increase reliability

| Ways in which to increase reliability | Application to the study |
|---|---|
| Use technically correct, unambiguous items | Likert scales were used to avoid any misunderstandings. |
| Standardise the administration procedures | The survey was conducted during class (one for each group of students). Each class was given the same set of instructions and the same amount of time to complete the survey. |
| Standardise the scoring procedures | All questions were standardized. They were administered and scored in a consistent way. |
| Being alert for respondent irregularities | The students completed the questionnaire in a formalized test setting. |
| Make the test long enough to include a good sample of items | The survey consisted of a total 19 questions measuring each of the seven hypotheses. Four questions consisted of comprehensive sub-questions. Fifteen questions were background variables. |
| Be certain that each item on the test measures the same outcome or set of outcomes | The researcher is confident that she included enough questions for every outcome that she was trying to measure (see Table 3.4). |

Students were informed that their participation was voluntary and that the results would be used for research purposes only; they were urged to answer all questions as honestly as possible. The researcher endeavored to ensure that the measuring instrument was as reliable as possible. Factor analysis and the Cronbach Alpha Co-efficient were also used as a form of reliability.

### 3.10.1 Exploratory factor analysis

Exploratory factor analysis (EFA) is useful in research that involves many variables or items from questionnaires as in the case of this study. EFA is a 'data reduction' technique which was used to reduce a large number of related variables to a smaller more manageable group by identifying relationships and patterns between the items and the dependent variable (Pallant, 2013). EFA considers useful factors rather than inconsequential factors by placing the variables into meaningful categories (Young & Pearce, 2013). This was done by:

**Step 1: Assessment of the suitability of the data for factor analysis –**
The two considerations made for this step were sample size and strength of the relationship among the variables. According to Tabachnick & Fidell (2013) the minimum sample size should be at least 300. The sample size for this study was a total of 379 which meets this requirement. Regarding the strength of the relationship, correlations amongst the items were examined. Tabachnick & Fidell (2013) suggest only correlation coefficients that are greater than .30 in the pattern matrix. Variables that had a large number of low correlation coefficients ($r < +/- .30$) were removed as they indicated a lack of patterned relationships.

**Step 2: Factor extraction -**
Factor extraction is the identification of the smallest subset of factors that can be used to show interrelationships amongst the variables (Pallant, 2013). The image factoring approach was used to identify these interrelationships amongst the variables.

**Step 3: Factor rotation and interpretation**

Using the factors from step 2 the next step was to interpret the factors using the rotation matrix. This was done by scanning the matrix and identifying strongly loaded variables.

Question 8, 12, 13 and 24 of the SPQ consisted of several sub-questions. Steps 1 to 3 were applied to these questions as follows: Firstly, a correlation matrix was generated for all the variables. Secondly, factors were extracted from the correlation matrix based on the correlation coefficients of the variables. Thirdly, the factors were then rotated in order to maximize the relationship between the variables and some of the factors.

3.10.1.1 Question 8.1 (Critical thinking at school)

The items were subjected to an exploratory factor analysis (EFA) using SPSS. Prior to performing EFA the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of several coefficients of .3 and above. The Kaiser-Meyer-Olkin (KMO) value was .919, exceeding the recommended value of .6 (Pallant, 2013) and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. The EFA revealed the presence of 6 factors with an eigenvalue exceeding 1, explaining 34.33%, 5.66%, 4.62%, 4.36%, 4.02% and 3.72% of the variance respectively. An inspection of the screeplot revealed a clear break after the sixth factor. The six-component solution explained a total of 56.71% of the variance. A second exploratory factor analysis was computed excluding selected items with low loadings in Table 3.6.

**Table 3.6:** Correlation matrix

| | Q8.1.4 I was encouraged to use mind maps to show how things relate to each other | Q8.1.5 I was encouraged to use tables to organise information | Q8.1.6 I was encouraged to consider the advantages and disadvantages before making | Q8.1.8 I was encouraged to find multiple solutions to problems | Q8.1.9 I was encouraged to use Brainstorming techniques when I had to solve problems | Q8.1.10 I was encouraged to break a problem into different parts in order to solve it | Q8.1.11 I was encouraged to think independently of others, to have my own mind about matters | Q8.1.12 I was encouraged to attend extra lessons to improve my performance in subjects | Q8.1.13 I was encouraged to regularly study after hours or study extra hours to improve my marks | Q8.1.14 I was encouraged to study hard so that I could achieve university entrance | Q8.1.16 I was encouraged to check my work for mistakes before I submitted it | Q8.1.21 I was encouraged to read a lot to improve my knowledge | Q8.1.23 I was encouraged to take notes in class that I could use to study from | Q8.1.24 I was encouraged to work or study in groups with my peers | Q8.1.25 I was encouraged to have an inquiring mind and to always ask questions | Q8.1.26 I was encouraged to question authority if I believed people in authority were wrong | Q8.1.27 I was encouraged to ask others to help solve problems |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q8.1.4 | 1.000 | .411 | .327 | .323 | .442 | .320 | .148 | .254 | .290 | .224 | .296 | .231 | .284 | .220 | .241 | .119 | .180 |
| Q8.1.5 | .411 | 1.000 | .380 | .271 | .292 | .328 | .197 | .195 | .174 | .189 | .243 | .180 | .211 | .222 | .222 | .146 | .109 |
| Q8.1.6 | .327 | .380 | 1.000 | .342 | .286 | .423 | .183 | .262 | .269 | .269 | .314 | .245 | .292 | .233 | .215 | .105 | .249 |
| Q8.1.8 | .323 | .271 | .342 | 1.000 | .479 | .449 | .271 | .252 | .391 | .270 | .362 | .337 | .324 | .342 | .393 | .263 | .299 |
| Q8.1.9 | .442 | .292 | .286 | .479 | 1.000 | .478 | .229 | .241 | .385 | .243 | .375 | .271 | .300 | .280 | .351 | .238 | .321 |
| Q8.1.10 | .320 | .328 | .423 | .449 | .478 | 1.000 | .302 | .317 | .266 | .259 | .379 | .349 | .361 | .297 | .430 | .275 | .379 |
| Q8.1.11 | .148 | .197 | .183 | .271 | .229 | .302 | 1.000 | .086 | .149 | .234 | .207 | .161 | .203 | .106 | .296 | .339 | .110 |
| Q8.1.12 | .254 | .195 | .262 | .252 | .241 | .317 | .086 | 1.000 | .394 | .385 | .355 | .299 | .349 | .359 | .259 | .222 | .291 |
| Q8.1.13 | .290 | .174 | .269 | .391 | .385 | .266 | .149 | .394 | 1.000 | .502 | .458 | .475 | .350 | .367 | .354 | .219 | .329 |
| Q8.1.14 | .224 | .189 | .269 | .270 | .243 | .259 | .234 | .385 | .502 | 1.000 | .437 | .351 | .303 | .272 | .250 | .217 | .334 |
| Q8.1.16 | .296 | .243 | .314 | .362 | .375 | .379 | .207 | .355 | .458 | .437 | 1.000 | .541 | .406 | .346 | .404 | .283 | .456 |
| Q8.1.21 | .231 | .180 | .245 | .337 | .271 | .349 | .161 | .299 | .475 | .351 | .541 | 1.000 | .490 | .449 | .419 | .263 | .406 |
| Q8.1.23 | .284 | .211 | .292 | .324 | .300 | .361 | .203 | .349 | .350 | .303 | .406 | .490 | 1.000 | .511 | .395 | .245 | .427 |
| Q8.1.24 | .220 | .222 | .233 | .342 | .280 | .297 | .106 | .359 | .367 | .272 | .346 | .449 | .511 | 1.000 | .420 | .204 | .536 |
| Q8.1.25 | .241 | .222 | .215 | .393 | .351 | .430 | .296 | .259 | .354 | .250 | .404 | .419 | .395 | .420 | 1.000 | .372 | .383 |
| Q8.1.26 | .119 | .146 | .105 | .263 | .238 | .275 | .339 | .222 | .219 | .217 | .283 | .263 | .245 | .204 | .372 | 1.000 | .336 |
| Q8.1.27 | .180 | .109 | .249 | .299 | .321 | .379 | .110 | .291 | .329 | .334 | .456 | .406 | .427 | .536 | .383 | .336 | 1.000 |

Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above.

**Table 3.7:** KMO and Bartlett's test

| KMO and Bartlett's Test | | |
|---|---|---|
| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | | .898 |
| **Bartlett's Test of Sphericity** | Approx. Chi-Square | 1671.702 |
| | df | 136 |
| | Sig. | .000 |



The KMO value was .898 exceeding the recommended value of .6 (Kaiser, 1970). The Barrlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

**Table 3.8:** Total variance explained

| Total Variance Explained | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Factor** | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings[a] |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| **1** | 5.981 | 35.185 | 35.185 | 5.397 | 31.749 | 31.749 | 4.782 |
| **2** | 1.448 | 8.515 | 43.700 | .846 | 4.977 | 36.727 | 3.383 |
| **3** | 1.198 | 7.050 | 50.750 | .548 | 3.224 | 39.951 | 2.526 |
| **4** | .998 | 5.868 | 56.618 | | | | |
| **5** | .848 | 4.986 | 61.603 | | | | |
| **6** | .754 | 4.434 | 66.038 | | | | |
| **7** | .748 | 4.403 | 70.441 | | | | |
| **8** | .678 | 3.988 | 74.429 | | | | |
| **9** | .626 | 3.681 | 78.110 | | | | |
| **10** | .612 | 3.602 | 81.712 | | | | |
| **11** | .559 | 3.288 | 85.000 | | | | |
| **12** | .514 | 3.024 | 88.024 | | | | |
| **13** | .472 | 2.776 | 90.800 | | | | |
| **14** | .456 | 2.680 | 93.480 | | | | |
| **15** | .433 | 2.550 | 96.030 | | | | |
| **16** | .358 | 2.104 | 98.134 | | | | |
| **17** | .317 | 1.866 | 100.000 | | | | |

**Extraction Method: Principal Axis Factoring.**
**a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.**

In Table 3.8 the first 3 factors recorded an eigenvalue above 1. Factor 1 = 5.981; Factor 2 = 1.448; Factor 3 = 1.198.



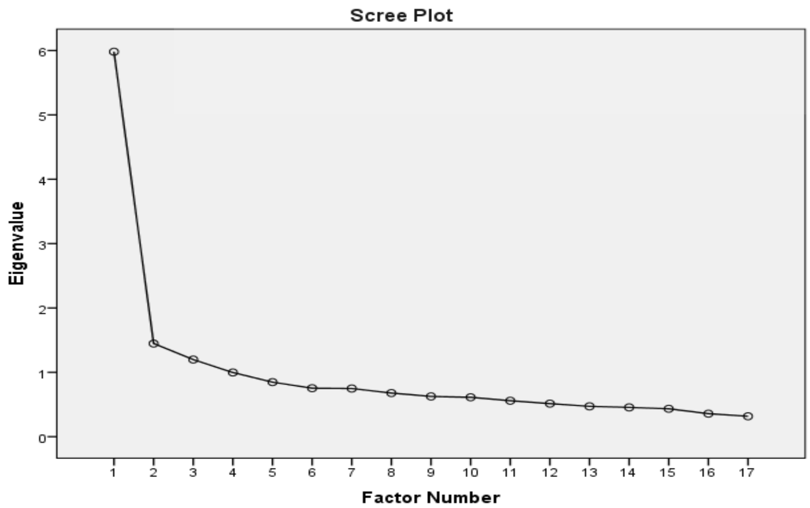



**Figure 3.14:** Scree plot (critical thinking at school)

In Figure 3.14 the curve begins to flatten between factors 4 and 17. Factor 4 has an eigenvalue less than 1, therefore only 3 factors have been retained.

**Table 3.9:** Pattern matrix

| Pattern Matrix[a] | | | |
|---|---|---|---|
| | Factor | | |
| | 1 | 2 | 3 |
| Q8.1.21 I was encouraged to read a lot to improve my knowledge | .703 | | |
| Q8.1.24 I was encouraged to work or study in groups with my peers | .662 | | |
| Q8.1.27 I was encouraged to ask others to help solve problems | .636 | | |
| Q8.1.13 I was encouraged to regularly study after hours or study extra hours to improve my marks | .635 | | |
| Q8.1.16 I was encouraged to check my work for mistakes before I submitted it | .595 | | |
| Q8.1.23 I was encouraged to take notes in class that I could use to study from | .582 | | |
| Q8.1.14 I was encouraged to study hard so that I could achieve university entrance | .528 | | |
| Q8.1.12 I was encouraged to attend extra lessons to improve my performance in subjects | .510 | | |
| Q8.1.4 I was encouraged to use mind maps to show how things relate to each other | | .623 | |
| Q8.1.5 I was encouraged to use tables to organise information | | .591 | |
| Q8.1.6 I was encouraged to consider the advantages and disadvantages before making choices | | .510 | |
| Q8.1.9 I was encouraged to use Brainstorming techniques when I had to solve problems | | .467 | |
| Q8.1.10 I was encouraged to break a problem into different parts in order to solve it | | .410 | .342 |
| Q8.1.8 I was encouraged to find multiple solutions to problems | | .361 | |
| Q8.1.26 I was encouraged to question authority if I believed people in authority were wrong | | | .504 |
| Q8.1.11 I was encouraged to think independently of others, to have my own mind about matters | | | .475 |
| Q8.1.25 I was encouraged to have an inquiring mind and to always ask questions | .346 | | .433 |

**Extraction Method: Principal Axis Factoring.**
**Rotation Method: Oblimin with Kaiser Normalization.**
**a. Rotation converged in 7 iterations.**

Table 3.9 shows that eight items Q8.1.21, 8.1.24, 8.1.27, 8.1.13, 8.1.16, 8.1.23, 8.1.14 and 8.1.12 - are substantially loaded on Factor 1. Six items 8.1.4, 8.1.5, 8.1.6, 8.1.9, 8.1.10 and 8.1.8 – are substantially loaded on Factor 2 and three items 8.1.26, 8.1.11 and 8.1.25 – are substantially loaded on Factor 3. Table 3.10 summarises the factor items which can now be used as variables for further analysis.

**Table 3.10:** Factor items for Question 8.1.1 - 8.1.27 (Critical thinking at school)

| Items | Questions |
|---|---|
| **Factor 1 - encouraged to develop good study habits** | Q8.1.21, 8.1.24, 8.1.27, 8.1.13, 8.1.16, 8.1.23, 8.1.14, 8.1.12 |
| **Factor 2 – encouraged to analyse ones work** | 8.1.4, 8.1.5, 8.1.6, 8.1.9, 8.1.10 |
| **Factor 3 - encouraged to think independently** | 8.1.26, 8.1.11 |

3.10.1.2 Question 8.2 (Critical thinking at home)

The items were subjected to an exploratory factor analysis (EFA) using SPSS. Prior to performing EFA the suitability of the data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of several coefficients of .3 and above. The Kaiser-Meyer-Olkin (KMO) value was .909, exceeding the recommended value of .6 (Pallant, 2013) and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. The EFA revealed the presence of 6 factors with an eigenvalue exceeding 1, explaining 33.53%, 7.37%, 5.90%, 4.31%, 3.99% and 3.76% of the variance respectively. An inspection of the screeplot revealed a clear break after the sixth factor. The six-component solution explained a total of 58.86% of the variance. A second exploratory factor analysis was computed excluding selected items with low loadings as follows:



**Table 3.11:** Correlation matrix

| | Q8.2.4 I was encouraged to use mind maps to show how things relate to each other | Q8.2.5 I was encouraged to use tables to organise information | Q8.2.9 I was encouraged to use Brainstorming techniques when I had to solve problems | Q8.2.12 I was encouraged to attend extra lessons to improve my performance in subjects | Q8.2.13 I was encouraged to regularly study after hours or study extra hours to improve my marks | Q8.2.14 I was encouraged to study hard so that I could achieve university entrance | Q8.2.20 I was encouraged to be creative when I had to complete tasks | Q8.2.21 I was encouraged to read a lot to improve my knowledge | Q8.2.22 I was encouraged to play games that required problem-solving skills | Q8.2.23 I was encouraged to take notes in class that I could use to study from | Q8.2.24 I was encouraged to work or study in groups with my peers | Q8.2.25 I was encouraged to have an inquiring mind and to always ask questions | Q8.2.26 I was encouraged to question authority if I believed people in authority were wrong | Q8.2.27 I was encouraged to ask others to help solve problems |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q8.2.4 I | 1.000 | .518 | .460 | .166 | .211 | .162 | .328 | .285 | .219 | .363 | .226 | .334 | .308 | .108 |
| Q8.2.5 | .518 | 1.000 | .351 | .155 | .211 | .112 | .214 | .175 | .202 | .214 | .183 | .353 | .258 | .074 |
| Q8.2.9 | .460 | .351 | 1.000 | .295 | .299 | .254 | .381 | .353 | .298 | .323 | .221 | .282 | .284 | .208 |
| Q8.2.12 | .166 | .155 | .295 | 1.000 | .535 | .436 | .289 | .277 | .118 | .350 | .374 | .359 | .174 | .336 |
| Q8.2.13 | .211 | .211 | .299 | .535 | 1.000 | .599 | .284 | .374 | .153 | .385 | .292 | .353 | .161 | .353 |
| Q8.2.14 | .162 | .112 | .254 | .436 | .599 | 1.000 | .308 | .467 | .105 | .355 | .227 | .303 | .195 | .359 |
| Q8.2.20 | .328 | .214 | .381 | .289 | .284 | .308 | 1.000 | .447 | .395 | .439 | .328 | .327 | .332 | .291 |
| Q8.2.21 | .285 | .175 | .353 | .277 | .374 | .467 | .447 | 1.000 | .427 | .451 | .374 | .400 | .317 | .348 |

| | Q8.2.4 I was encouraged to use mind maps to show how things relate to each other | Q8.2.5 I was encouraged to use tables to organise information | Q8.2.9 I was encouraged to use Brainstorming techniques when I had to solve problems | Q8.2.12 I was encouraged to attend extra lessons to improve my performance in subjects | Q8.2.13 I was encouraged to regularly study after hours or study extra hours to improve my marks | Q8.2.14 I was encouraged to study hard so that I could achieve university entrance | Q8.2.20 I was encouraged to be creative when I had to complete tasks | Q8.2.21 I was encouraged to read a lot to improve my knowledge | Q8.2.22 I was encouraged to play games that required problem-solving skills | Q8.2.23 I was encouraged to take notes in class that I could use to study from | Q8.2.24 I was encouraged to work or study in groups with my peers | Q8.2.25 I was encouraged to have an inquiring mind and to always ask questions | Q8.2.26 I was encouraged to question authority if I believed people in authority were wrong | Q8.2.27 I was encouraged to ask others to help solve problems |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q8.2.22 | .219 | .202 | .298 | .118 | .153 | .105 | .395 | .427 | 1.000 | .364 | .390 | .295 | .375 | .185 |
| Q8.2.23 | .363 | .214 | .323 | .350 | .385 | .355 | .439 | .451 | .364 | 1.000 | .456 | .535 | .374 | .377 |
| Q8.2.24 | .226 | .183 | .221 | .374 | .292 | .227 | .328 | .374 | .390 | .456 | 1.000 | .370 | .373 | .390 |
| Q8.2.25 | .334 | .353 | .282 | .359 | .353 | .303 | .327 | .400 | .295 | .535 | .370 | 1.000 | .428 | .363 |
| Q8.2.26 | .308 | .258 | .284 | .174 | .161 | .195 | .332 | .317 | .375 | .374 | .373 | .428 | 1.000 | .309 |
| Q8.2.27 | .108 | .074 | .208 | .336 | .353 | .359 | .291 | .348 | .185 | .377 | .390 | .363 | .309 | 1.000 |

Inspection of the correlation matrix revealed the presence of several coefficients of .3 and above.

**Table 3.12:** KMO and Bartlett's test

| KMO and Bartlett's Test | | |
|---|---|---|
| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | | .873 |
| **Bartlett's Test of Sphericity** | Approx. Chi-Square | 1331.791 |
| | df | 91 |
| | Sig. | .000 |

The KMO value was .873. The Barrlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

**Table 3.13:** Total variance explained

| Total Variance Explained | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Factor** | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings[a] |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| **1** | 5.111 | 36.507 | 36.507 | 4.565 | 32.606 | 32.606 | 3.824 |
| **2** | 1.547 | 11.052 | 47.560 | 1.056 | 7.543 | 40.150 | 3.006 |
| **3** | 1.215 | 8.682 | 56.241 | .688 | 4.914 | 45.064 | 2.447 |
| **4** | .907 | 6.481 | 62.722 | | | | |
| **5** | .717 | 5.125 | 67.847 | | | | |
| **6** | .673 | 4.805 | 72.651 | | | | |
| **7** | .622 | 4.440 | 77.092 | | | | |
| **8** | .583 | 4.167 | 81.259 | | | | |
| **9** | .544 | 3.889 | 85.148 | | | | |
| **10** | .534 | 3.817 | 88.964 | | | | |
| **11** | .463 | 3.308 | 92.273 | | | | |
| **12** | .394 | 2.812 | 95.085 | | | | |
| **13** | .355 | 2.533 | 97.618 | | | | |
| **14** | .334 | 2.382 | 100.000 | | | | |

**Extraction Method: Principal Axis Factoring.**
**a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.**

In Table 3.13 the first 3 factors recorded an eigenvalue above 1. Factor 1 = 5.111; Factor 2 = 1.547; Factor 3 = 1.215.



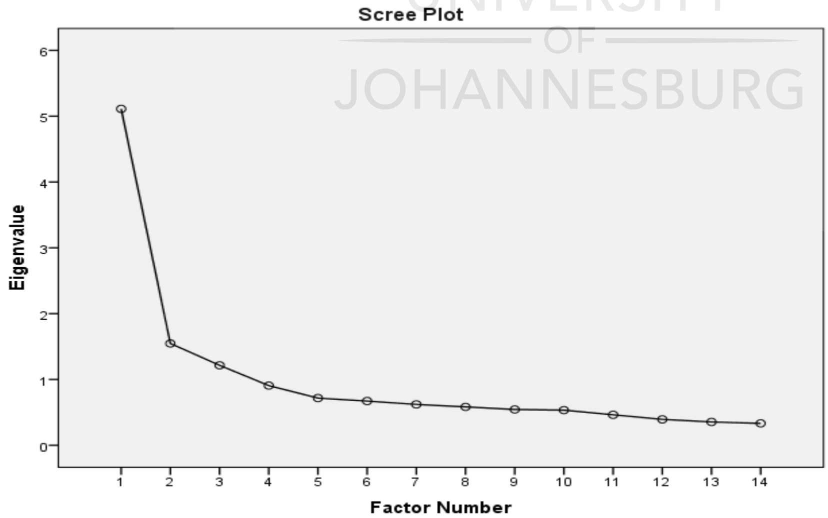



**Figure 3.15:** Scree plot (critical thinking at home)

In Figure 3.15 the curve begins to flatten between factors 4 and 14. Factor 4 has an eigenvalue less than 1, therefore only 3 factors have been retained.

**Table 3.14:** Pattern matrix

| Pattern Matrix[a] | | | |
|---|---|---|---|
| | **Factor** | | |
| | **1** | **2** | **3** |
| Q8.2.22 I was encouraged to play games that required problem-solving skills | .694 | | |
| Q8.2.24 I was encouraged to work or study in groups with my peers | .612 | | |
| Q8.2.26 I was encouraged to question authority if I believed people in authority were wrong | .580 | | |
| Q8.2.23 I was encouraged to take notes in class that I could use to study from | .547 | | |
| Q8.2.21 I was encouraged to read a lot to improve my knowledge | .504 | | |
| Q8.2.20 I was encouraged to be creative when I had to complete tasks | .472 | | |
| Q8.2.25 I was encouraged to have an inquiring mind and to always ask questions | .427 | | |
| Q8.2.27 I was encouraged to ask others to help solve problems | .421 | -.319 | |
| Q8.2.13 I was encouraged to regularly study after hours or study extra hours to improve my marks | | -.807 | |
| Q8.2.14 I was encouraged to study hard so that I could achieve university entrance | | -.718 | |
| Q8.2.12 I was encouraged to attend extra lessons to improve my performance in subjects | | -.590 | |
| Q8.2.4 I was encouraged to use mind maps to show how things relate to each other | | | .777 |
| Q8.2.5 I was encouraged to use tables to organise information | | | .664 |
| Q8.2.9 I was encouraged to use Brainstorming techniques when I had to solve problems | | | .444 |

**Extraction Method: Principal Axis Factoring.**
**Rotation Method: Oblimin with Kaiser Normalization.**
**a. Rotation converged in 9 iterations.**



Table 3.14 shows that eight items Q8.2.22, Q8.2.24, Q8.2.26, Q8.2.23, Q8.2.21, Q8.2.20, Q8.2.25 and Q8.2.27 - are substantially loaded on Factor 1. Three items Q8.2.13, Q8.2.14 and Q8.2.12 – are substantially loaded on Factor 2. Three items Q8.2.4, Q8.2.5, and Q8.2.9 – are substantially loaded on Factor 3. Table 3.13 summarises the factor items which can now be used as variables for further analysis.

**Table 3.15:** Factor items for Question 8.2.1 - 8.2.27 (Critical thinking at home)

| Items | Questions |
|---|---|
| **Factor 1 – encouraged to develop higher order thinking skills** | Q8.2.22, Q8.2.24, Q8.2.26, Q8.2.23, Q8.2.21, Q8.2.20, Q8.2.25 and Q8.2.27 |
| **Factor 2 – encouraged to do additional work** | Q8.2.27, Q8.2.13, Q8.2.14 and Q8.2.12 |
| **Factor 3 – encouraged to recognised the structure of content** | Q8.2.4, Q8.2.5, and Q8.2.9 |

3.10.1.3 Question 12 (Teaching)

The items were subjected to an exploratory factor analysis (EFA) using SPSS. Prior to performing EFA the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Olkin (KMO) value was .928, exceeding the recommended value of .6 (Pallant, 2013) and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. The EFA revealed the presence of 5 factors with an eigenvalue exceeding 1, explaining 36.36%, 6.50%, 4.96%, 4.81% and 4.48% of the variance respectively. An inspection of the scree plot revealed a clear break after the fifth factor. The five-component solution explained a total of 57.11% of the variance. A second exploratory factor analysis was computed excluding selected items with low loadings as follows:

**Table 3.16:** Correlation matrix

| | Q12.2 My teachers encouraged us to learn from more than just the textbook | Q12.3 My teachers taught by reading a transparency on an overhead projector | Q12.4 In my school, each learners had his/her own textbooks | Q12.7 My teachers encouraged debating during class times | Q12.8 My teachers encouraged learners to know their work "off by heart" | Q12.9 My teachers encouraged learners to have alternative opinions | Q12.11 My teachers taught more than just the textbook | Q12.12 My teachers expected their learners to be critical thinkers | Q12.19 My teachers challenged learners to extend themselves | Q12.20 My teachers taught us how to think abstractly | Q12.21 My teachers made a deliberate effort to develop higher-order thinking skills |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Q12.2 | 1.000 | .086 | .275 | .313 | .180 | .336 | .349 | .327 | .342 | .308 | .357 |
| Q12.3 | .086 | 1.000 | .245 | .063 | -.079 | .066 | .215 | .055 | .097 | .091 | .119 |
| Q12.4 | .275 | .245 | 1.000 | .209 | .063 | .207 | .395 | .356 | .279 | .280 | .284 |
| Q12.7 | .313 | .063 | .209 | 1.000 | .299 | .357 | .379 | .333 | .301 | .366 | .387 |
| Q12.8 | .180 | -.079 | .063 | .299 | 1.000 | .337 | .161 | .169 | .228 | .284 | .251 |
| Q12.9 | .336 | .066 | .207 | .357 | .337 | 1.000 | .332 | .323 | .390 | .417 | .378 |
| Q12.11 | .349 | .215 | .395 | .379 | .161 | .332 | 1.000 | .463 | .374 | .457 | .484 |
| Q12.12 | .327 | .055 | .356 | .333 | .169 | .323 | .463 | 1.000 | .485 | .486 | .516 |
| Q12.19 | .342 | .097 | .279 | .301 | .228 | .390 | .374 | .485 | 1.000 | .530 | .450 |
| Q12.20 | .308 | .091 | .280 | .366 | .284 | .417 | .457 | .486 | .530 | 1.000 | .533 |
| Q12.21 | .357 | .119 | .284 | .387 | .251 | .378 | .484 | .516 | .450 | .533 | 1.000 |

Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above.

**Table 3.17:** KMO and Bartlett's test

| KMO and Bartlett's Test | | |
|---|---|---|
| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | | .896 |
| **Bartlett's Test of Sphericity** | Approx. Chi-Square | 868.494 |
| | df | 55 |
| | Sig. | .000 |

The KMO value was .896. The Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

**Table 3.18:** Total variance explained

| Total Variance Explained | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Factor** | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings[a] |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| **1** | 4.184 | 38.032 | 38.032 | 3.606 | 32.781 | 32.781 | 3.536 |
| **2** | 1.260 | 11.459 | 49.491 | .549 | 4.990 | 37.772 | .920 |
| **3** | .880 | 7.996 | 57.487 | | | | |
| **4** | .767 | 6.968 | 64.455 | | | | |
| **5** | .710 | 6.459 | 70.914 | | | | |
| **6** | .688 | 6.252 | 77.167 | | | | |
| **7** | .590 | 5.361 | 82.528 | | | | |
| **8** | .554 | 5.038 | 87.566 | | | | |
| **9** | .487 | 4.430 | 91.996 | | | | |
| **10** | .465 | 4.232 | 96.227 | | | | |
| **11** | .415 | 3.773 | 100.000 | | | | |

**Extraction Method: Principal Axis Factoring.**
**a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.**

In Table 3.18 the first 2 factors recorded an eigenvalue above 1. Factor 1 = 4.184 and Factor 2 = 1.260

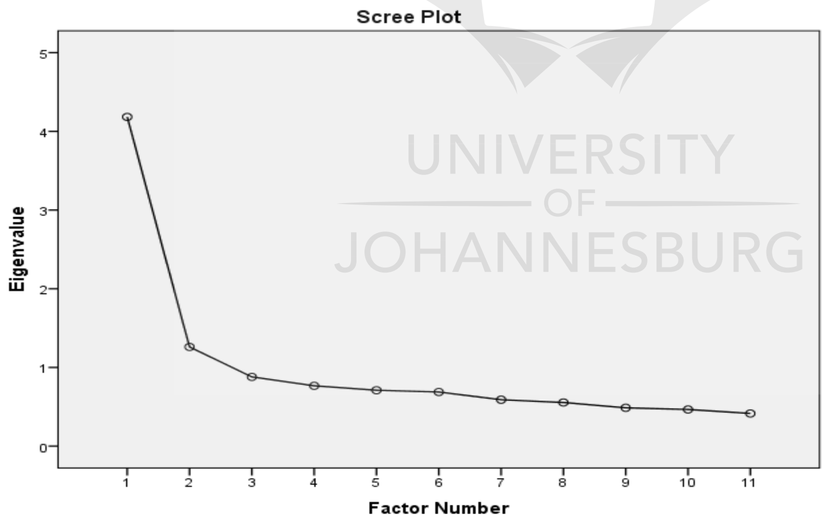





**Figure 3.16:** Scree plot (teaching)

In Figure 3.16 the curve begins to flatten between factors 3 and 11. Factor 3 has an eigenvalue less than 1, therefore only 2 factors have been retained.

**Table 3.19:** Pattern matrix

| Pattern Matrix[a] | | |
|---|---|---|
| | Factor | |
| | 1 | 2 |
| Q12.20 My teachers taught us how to think abstractly | .712 | |
| Q12.21 My teachers made a deliberate effort to develop higher-order thinking skills like analysis, comparisons, evaluation, etc | .681 | |
| Q12.19 My teachers challenged learners to extend themselves | .636 | |
| Q12.9 My teachers encouraged learners to have alternative opinions | .628 | |
| Q12.12 My teachers expected their learners to be critical thinkers | .613 | |
| Q12.7 My teachers encouraged debating during class times | .570 | |
| Q12.11 My teachers taught more than just the textbook | .560 | .335 |
| Q12.8 My teachers encouraged learners to know their work "off by heart" | .496 | -.354 |
| Q12.2 My teachers encouraged us to learn from more than just the textbook | .489 | |
| Q12.4 In my school, each learners had his/her own textbooks | .321 | .431 |
| Q12.3 My teachers taught by reading a transparency on an overhead projector | | .382 |

**Extraction Method: Principal Axis Factoring.**
**Rotation Method: Oblimin with Kaiser Normalization.**
**a. Rotation converged in 9 iterations.**

Table 3.19 shows that Factor 2 items Q12.11, Q12.8 and Q12.4 are cross loaded with Factor 1 items, hence only one factor item will be reported on as shown in Table 3.20. Q12.8 and Q12.3 were removed due to their lack of 'fit'. This factor can now be used as a variable for further analysis.

**Table 3.20:** Factor items for 12.1 - 12.23 (Teaching)

| Items | Questions |
|---|---|
| **Constructive teaching** | Q12.20, Q12.21, Q12.19, Q12.9, Q12.12, Q12.7, Q12.11, Q12.2, Q12.4 |



3.10.1.4 Question 13 (Learning)

The items were subjected to an exploratory factor analysis (EFA) using SPSS. Prior to performing EFA the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Olkin (KMO) value was .929, exceeding the recommended value of .6 (Pallant, 2013) and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix. The EFA revealed the presence of 5 factors with an eigenvalue exceeding 1, explaining 38.05%, 8.56%, 4.61%, 4.15% and 4.04% of the variance respectively. An inspection of the screeplot revealed a clear break after the fifth factor. The five-component solution explained a total of 59.41% of the variance. A second exploratory factor analysis was computed excluding selected items with low loadings as follows:

**Table 3.21:** Correlation matrix

| | Q13.1 I plan first before I begin with a task | Q13.2 I keep checking that I'm on the right track while I'm busy with a task | Q13.3 I work hard at a task even though I don't like a task | Q13.4 I believe I will perform well in this course | Q13.6 I'm convinced that I will understand the most parts of this course | Q13.7 I try to understand problems before I attempt to solve them | Q13.8 I work as hard as possible on all tasks given to me | Q13.9 I'm convinced that I will understand the basic parts of this course | Q13.10 I try to understand the goal of a task before I attempt to complete it | Q13.12 I do extra work on tasks to improve my knowledge | Q13.14 I am focussed on the task at hand and do not get distracted easily | Q13.15 I check and correct my errors before I submit a task | Q13.16 I work hard on a task even if it does not count | Q13.17 I expect to do well in this course | Q13.18 I make sure I understand what has to be done and how to do it before I start a task | Q13.20 A task is a useful way to check my knowledge of something | Q13.22 I try to determine all the requirements of a task before I begin it | Q13.23 I ask myself how well am I doing, as I progress through tasks | Q13.25 Considering my skills and knowledge, I think I will do well in this course | Q13.26 I know which parts of the work I know well and which I do not know well |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q13.1 | 1.000 | .533 | .286 | .250 | .232 | .274 | .317 | .231 | .416 | .348 | .292 | .319 | .279 | .244 | .327 | .305 | .382 | .262 | .239 | .182 |
| Q13.2 | .533 | 1.000 | .439 | .345 | .323 | .389 | .391 | .300 | .485 | .283 | .343 | .422 | .273 | .330 | .386 | .368 | .504 | .381 | .289 | .259 |
| Q13.3 | .286 | .439 | 1.000 | .328 | .258 | .234 | .416 | .228 | .339 | .333 | .412 | .393 | .442 | .279 | .337 | .256 | .435 | .300 | .264 | .327 |
| Q13.4 | .250 | .345 | .328 | 1.000 | .528 | .327 | .325 | .610 | .276 | .237 | .202 | .334 | .135 | .647 | .373 | .313 | .357 | .250 | .565 | .358 |
| Q13.6 | .232 | .323 | .258 | .528 | 1.000 | .333 | .344 | .605 | .288 | .241 | .218 | .337 | .157 | .420 | .281 | .281 | .321 | .243 | .525 | .331 |
| Q13.7 | .274 | .389 | .234 | .327 | .333 | 1.000 | .464 | .342 | .450 | .290 | .311 | .323 | .187 | .415 | .544 | .331 | .455 | .272 | .351 | .267 |
| Q13.8 | .317 | .391 | .416 | .325 | .344 | .464 | 1.000 | .304 | .359 | .357 | .451 | .396 | .414 | .363 | .444 | .356 | .450 | .339 | .313 | .239 |
| Q13.9 | .231 | .300 | .228 | .610 | .605 | .342 | .304 | 1.000 | .343 | .189 | .195 | .326 | .102 | .525 | .359 | .333 | .360 | .252 | .560 | .399 |
| Q13.10 | .416 | .485 | .339 | .276 | .288 | .450 | .359 | .343 | 1.000 | .296 | .344 | .389 | .256 | .273 | .444 | .361 | .471 | .344 | .354 | .235 |
| Q13.12 | .348 | .283 | .333 | .237 | .241 | .290 | .357 | .189 | .296 | 1.000 | .376 | .413 | .459 | .216 | .338 | .313 | .367 | .378 | .273 | .305 |
| Q13.14 | .292 | .343 | .412 | .202 | .218 | .311 | .451 | .195 | .344 | .376 | 1.000 | .384 | .414 | .261 | .321 | .247 | .439 | .353 | .232 | .227 |
| Q13.15 | .319 | .422 | .393 | .334 | .337 | .323 | .396 | .326 | .389 | .413 | .384 | 1.000 | .443 | .331 | .424 | .381 | .462 | .417 | .393 | .280 |
| Q13.16 | .279 | .273 | .442 | .135 | .157 | .187 | .414 | .102 | .256 | .459 | .414 | .443 | 1.000 | .172 | .351 | .277 | .305 | .302 | .226 | .177 |
| Q13.17 | .244 | .330 | .279 | .647 | .420 | .415 | .363 | .525 | .273 | .216 | .261 | .331 | .172 | 1.000 | .431 | .344 | .378 | .362 | .572 | .370 |
| Q13.18 | .327 | .386 | .337 | .373 | .281 | .544 | .444 | .359 | .444 | .338 | .321 | .424 | .351 | .431 | 1.000 | .391 | .562 | .352 | .413 | .332 |
| Q13.20 | .305 | .368 | .256 | .313 | .281 | .331 | .356 | .333 | .361 | .313 | .247 | .381 | .277 | .344 | .391 | 1.000 | .514 | .411 | .354 | .319 |
| Q13.22 | .382 | .504 | .435 | .357 | .321 | .455 | .450 | .360 | .471 | .367 | .439 | .462 | .305 | .378 | .562 | .514 | 1.000 | .446 | .401 | .363 |
| Q13.23 | .262 | .381 | .300 | .250 | .243 | .272 | .339 | .252 | .344 | .378 | .353 | .417 | .302 | .362 | .352 | .411 | .446 | 1.000 | .390 | .439 |
| Q13.25 | .239 | .289 | .264 | .565 | .525 | .351 | .313 | .560 | .354 | .273 | .232 | .393 | .226 | .572 | .413 | .354 | .401 | .390 | 1.000 | .488 |
| Q13.26 | .182 | .259 | .327 | .358 | .331 | .267 | .239 | .399 | .235 | .305 | .227 | .280 | .177 | .370 | .332 | .319 | .363 | .439 | .488 | 1.000 |

Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above.

**Table 3.22:** KMO and Bartlett's test

| KMO and Bartlett's Test | | |
|---|---|---|
| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | | .924 |
| **Bartlett's Test of Sphericity** | Approx. Chi-Square | 2713.267 |
| | df | 190 |
| | Sig. | 0.000 |

The KMO value was .924. The Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

**Table 3.23:** Total variance explained

| Total Variance Explained | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Factor** | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sum of Squared Loadings[a] |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| **1** | 7.650 | 38.250 | 38.250 | 7.114 | 35.572 | 35.572 | 5.983 |
| **2** | 1.906 | 9.532 | 47.782 | 1.422 | 7.112 | 42.684 | 5.362 |
| **3** | 1.122 | 5.608 | 53.390 | .569 | 2.844 | 45.528 | 4.544 |
| **4** | .964 | 4.818 | 58.208 | | | | |
| **5** | .906 | 4.529 | 62.736 | | | | |
| **6** | .761 | 3.804 | 66.540 | | | | |
| **7** | .690 | 3.448 | 69.989 | | | | |
| **8** | .665 | 3.323 | 73.312 | | | | |
| **9** | .644 | 3.219 | 76.531 | | | | |
| **10** | .614 | 3.070 | 79.601 | | | | |
| **11** | .545 | 2.727 | 82.328 | | | | |
| **12** | .523 | 2.614 | 84.942 | | | | |
| **13** | .494 | 2.471 | 87.414 | | | | |
| **14** | .435 | 2.175 | 89.589 | | | | |
| **15** | .419 | 2.096 | 91.685 | | | | |
| **16** | .394 | 1.972 | 93.657 | | | | |
| **17** | .351 | 1.753 | 95.410 | | | | |
| **18** | .327 | 1.636 | 97.046 | | | | |
| **19** | .300 | 1.501 | 98.548 | | | | |
| **20** | .290 | 1.452 | 100.000 | | | | |

**Extraction Method: Principal Axis Factoring.**
**a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.**

In Table 3.23 the first 3 factors recorded an eigenvalue above 1. Factor 1 = 7.650, Factor 2 = 1.906 and Factor 3 = 1.122.

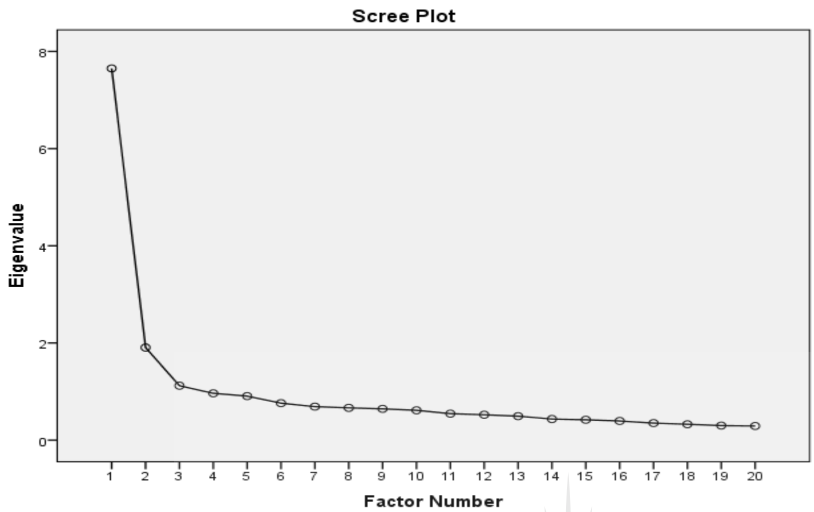



**Figure 3.17:** Scree plot (learning)

In Figure 3.17 the curve begins to flatten between factors 4 and 20. Factor 4 has an eigenvalue less than 1, therefore only 3 factors have been retained.

**Table 3.24:** Pattern matrix

| Pattern Matrix[a] | | | |
|---|---|---|---|
| | Factor | | |
| | 1 | 2 | 3 |
| Q13.10 I try to understand the goal of a task before I attempt to complete it | .715 | | |
| Q13.2 I keep checking that I'm on the right track while I'm busy with a task | .704 | | |
| Q13.7 I try to understand problems before I attempt to solve them | .617 | | |
| Q13.22 I try to determine all the requirements of a task before I begin it | .602 | | |
| Q13.1 I plan first before I begin with a task | .563 | | |
| Q13.18 I make sure I understand what has to be done and how to do it before I start a task | .507 | | |
| Q13.20 A task is a useful way to check my knowledge of something | .356 | | |
| Q13.8 I work as hard as possible on all tasks given to me | .342 | | .306 |
| Q13.4 I believe I will perform well in this course | | -.792 | |
| Q13.9 I'm convinced that I will understand the basic parts of this course | | -.786 | |
| Q13.25 Considering my skills and knowledge, I think I will do well in this course. | | -.769 | |
| Q13.17 I expect to do well in this course | | -.682 | |
| Q13.6 I'm convinced that I will understand the most parts of this course | | -.651 | |
| Q13.26 I know which parts of the work I know well and which I do not know well | | -.483 | |
| Q13.16 I work hard on a task even if it does not count | | | .801 |
| Q13.12 I do extra work on tasks to improve my knowledge | | | .555 |
| Q13.14 I am focussed on the task at hand and do not get distracted easily | | | .460 |
| Q13.3 I work hard at a task even though I don't like a task | | | .453 |
| Q13.15 I check and correct my errors before I submit a task | | | .423 |
| Q13.23 I ask myself how well am I doing, as I progress through tasks | | | .352 |

**Extraction Method: Principal Axis Factoring.**
**Rotation Method: Oblimin with Kaiser Normalization.**
**a. Rotation converged in 11 iterations.**

Table 3.24 shows that eight items Q13.10, Q13.2, Q13.7, Q13.22, Q13.18, Q13.1, Q13.20 and Q13.8 - are substantially loaded on Factor 1. Six items Q13.4, Q13.9, Q13.25, Q13.17, Q13.6 and Q13.26 – are substantially loaded on Factor 2. Six items Q13.16, Q13.12, Q13.14, Q13.3, Q13.15 and Q13.23 – are loaded on Factor 3. Table 3.25 summarises the factor items which can now be used as variables for further analysis.

**Table 3.25:** Factor items for Question 13.1 - 13.26 (Learning)

| Items | Questions |
|---|---|
| **Factor 1 - Meta-cognitive ability** | Q13.10, Q13.2, Q13.7, Q13.22, Q13.18, Q13.1, Q13.20 |
| **Factor 2 - Self-efficacy** | Q13.4, Q13.9, Q13.25, Q13.17, Q13.6, Q13.26 |
| **Factor 3 - Motivation to learn** | Q13.16, Q13.12, Q13.14, Q13.3,Q13.15 |

### 3.10.1.5 Question 24 (Digital Literacy)

**Table 3.26:** Correlation matrix

| | Q24.1 I used a computer in the home where I grew up | Q24.2 I used the Internet in the home where I grew up | Q24.3 I used a computer in the computer centre at school | Q24.4 I used the Internet on a computer at school | Q24.5 I used Internet Messaging (IM) like Yahoo/Windows Messenger or Mxit | Q24.6 I used search engines to search for information | Q24.7 I used the web for playing games | Q24.8 I accessed educational websites to learn more about my subjects | Q24.9 I used the web for banking, online ticketing, and other similar services | Q24.10 I used a web-based email account to send or receive email | Q24.11 I used the web to make phone calls (e.g. Skype) | Q24.12 I made use of cloud-based services like Google Drive, or Drop Box | Q24.13 I used a gaming console like Xbox, Playstation or Wii when I grew up | Q24.14 I used tools like MS Word, MS Excel or MS Publisher | Q24.15 I used computer-based music players (e.g. Winamp, Media Player, etc) | Q24.16 My teachers made use of computers to create learning materials | Q24.17 I used computers during classes to learn in my subjects | Q24.18 My teachers required that I use a computer for homework | Q24.19 I made use of Torrent services | Q24.22 I tried to have the latest version of a software programme | Q24.23 I tried to have the best hardware that I could afford |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q24.1 | 1.000 | .656 | .434 | .413 | .365 | .520 | .426 | .317 | .360 | .422 | .433 | .352 | .506 | .618 | .640 | .407 | .332 | .360 | .388 | .598 | .555 |
| Q24.2 | .656 | 1.000 | .387 | .391 | .399 | .451 | .494 | .356 | .451 | .399 | .481 | .384 | .512 | .411 | .452 | .377 | .387 | .358 | .381 | .436 | .425 |
| Q24.3 | .434 | .387 | 1.000 | .743 | .337 | .556 | .376 | .349 | .298 | .377 | .292 | .238 | .412 | .619 | .421 | .476 | .482 | .397 | .289 | .342 | .289 |
| Q24.4 | .413 | .391 | .743 | 1.000 | .333 | .504 | .438 | .417 | .358 | .338 | .390 | .280 | .411 | .505 | .405 | .505 | .479 | .422 | .338 | .336 | .251 |
| Q24.5 | .365 | .399 | .337 | .333 | 1.000 | .459 | .301 | .263 | .240 | .420 | .284 | .334 | .346 | .345 | .390 | .265 | .152 | .194 | .307 | .381 | .347 |
| Q24.6 | .520 | .451 | .556 | .504 | .459 | 1.000 | .427 | .482 | .350 | .577 | .267 | .289 | .409 | .571 | .595 | .470 | .316 | .381 | .330 | .490 | .428 |
| Q24.7 | .426 | .494 | .376 | .438 | .301 | .427 | 1.000 | .398 | .533 | .367 | .566 | .389 | .512 | .404 | .337 | .354 | .356 | .449 | .439 | .457 | .399 |
| Q24.8 | .317 | .356 | .349 | .417 | .263 | .482 | .398 | 1.000 | .373 | .510 | .359 | .356 | .304 | .352 | .358 | .350 | .403 | .368 | .333 | .398 | .368 |
| Q24.9 | .360 | .451 | .298 | .358 | .240 | .350 | .533 | .373 | 1.000 | .351 | .540 | .422 | .388 | .368 | .298 | .323 | .435 | .528 | .482 | .427 | .412 |
| Q24.10 | .422 | .399 | .377 | .338 | .420 | .577 | .367 | .510 | .351 | 1.000 | .382 | .346 | .336 | .494 | .473 | .391 | .314 | .306 | .343 | .493 | .449 |
| Q24.11 | .433 | .481 | .292 | .390 | .284 | .267 | .566 | .359 | .540 | .382 | 1.000 | .495 | .488 | .352 | .322 | .282 | .381 | .440 | .513 | .432 | .431 |
| Q24.12 | .352 | .384 | .238 | .280 | .334 | .289 | .389 | .356 | .422 | .346 | .495 | 1.000 | .321 | .283 | .275 | .181 | .317 | .318 | .378 | .396 | .359 |
| Q24.13 | .506 | .512 | .412 | .411 | .346 | .409 | .512 | .304 | .388 | .336 | .488 | .321 | 1.000 | .440 | .387 | .316 | .279 | .298 | .397 | .445 | .428 |
| Q24.14 | .618 | .411 | .619 | .505 | .345 | .571 | .404 | .352 | .368 | .494 | .352 | .283 | .440 | 1.000 | .689 | .491 | .436 | .405 | .349 | .510 | .516 |
| Q24.15 | .640 | .452 | .421 | .405 | .390 | .595 | .337 | .358 | .298 | .473 | .322 | .275 | .387 | .689 | 1.000 | .481 | .345 | .360 | .377 | .515 | .487 |
| Q24.16 | .407 | .377 | .476 | .505 | .265 | .470 | .354 | .350 | .323 | .391 | .282 | .181 | .316 | .491 | .481 | 1.000 | .515 | .441 | .291 | .349 | .315 |
| Q24.17 | .332 | .387 | .482 | .479 | .152 | .316 | .356 | .403 | .435 | .314 | .381 | .317 | .279 | .436 | .345 | .515 | 1.000 | .597 | .427 | .229 | .275 |
| Q24.18 | .360 | .358 | .397 | .422 | .194 | .381 | .449 | .368 | .528 | .306 | .440 | .318 | .298 | .405 | .360 | .441 | .597 | 1.000 | .522 | .361 | .378 |
| Q24.19 | .388 | .381 | .289 | .338 | .307 | .330 | .439 | .333 | .482 | .343 | .513 | .378 | .397 | .349 | .377 | .291 | .427 | .522 | 1.000 | .373 | .436 |
| Q24.22 | .598 | .436 | .342 | .336 | .381 | .490 | .457 | .398 | .427 | .493 | .432 | .396 | .445 | .510 | .515 | .349 | .229 | .361 | .373 | 1.000 | .779 |
| Q24.23 | .555 | .425 | .289 | .251 | .347 | .428 | .399 | .368 | .412 | .449 | .431 | .359 | .428 | .516 | .487 | .315 | .275 | .378 | .436 | .779 | 1.000 |

Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above.

**Table 3.27:** KMO and Bartlett's test

| KMO and Bartlett's Test | | |
|---|---|---|
| **Kaiser-Meyer-Olkin Measure of Sampling Adequacy.** | | .925 |
| **Bartlett's Test of Sphericity** | Approx. Chi-Square | 3122.267 |
| | df | 210 |
| | Sig. | 0.000 |

The KMO value was .925. The Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix.

**Table 3.28:** Total variance explained

| Total Variance Explained | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Factor** | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings[a] |
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total |
| **1** | 9.127 | 43.464 | 43.464 | 8.659 | 41.232 | 41.232 | 7.470 |
| **2** | 1.577 | 7.509 | 50.974 | 1.129 | 5.378 | 46.610 | 6.713 |
| **3** | 1.496 | 7.122 | 58.096 | 1.060 | 5.046 | 51.656 | 2.676 |
| **4** | .970 | 4.617 | 62.713 | | | | |
| **5** | .954 | 4.545 | 67.258 | | | | |
| **6** | .725 | 3.451 | 70.709 | | | | |
| **7** | .673 | 3.207 | 73.915 | | | | |
| **8** | .648 | 3.086 | 77.001 | | | | |
| **9** | .564 | 2.685 | 79.686 | | | | |
| **10** | .529 | 2.518 | 82.203 | | | | |
| **11** | .515 | 2.455 | 84.658 | | | | |
| **12** | .461 | 2.197 | 86.855 | | | | |
| **13** | .439 | 2.092 | 88.947 | | | | |
| **14** | .405 | 1.927 | 90.874 | | | | |
| **15** | .394 | 1.878 | 92.752 | | | | |
| **16** | .361 | 1.719 | 94.471 | | | | |
| **17** | .283 | 1.346 | 95.817 | | | | |
| **18** | .264 | 1.255 | 97.073 | | | | |
| **19** | .244 | 1.162 | 98.235 | | | | |
| **20** | .196 | .935 | 99.170 | | | | |
| **21** | .174 | .830 | 100.000 | | | | |

**Extraction Method: Principal Axis Factoring.**
**a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.**

In Table 3.28 the first 3 factors recorded an eigenvalue above 1. Factor 1 = 9.127, Factor 2 = 1.577 and Factor 3 = 1.496.

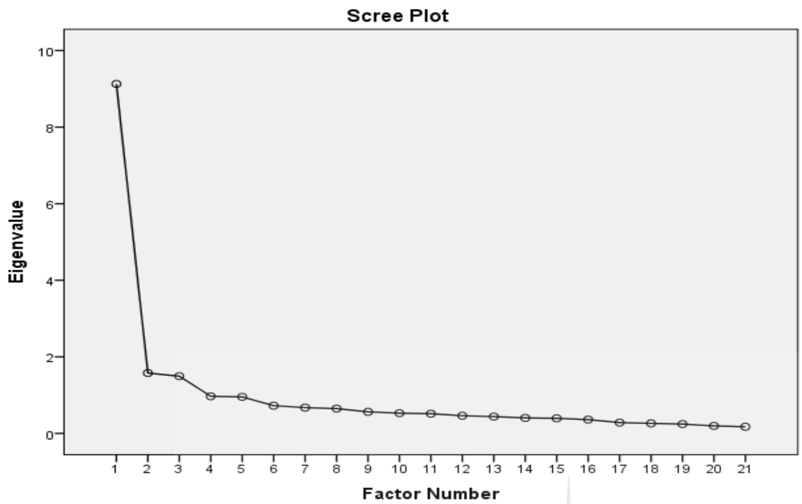



**Figure 3.18:** Scree plot (digital literacy)

In Figure 3.18 the curve begins to flatten between factors 4 and 21. Factor 4 has an eigenvalue less than 1, therefore only 3 factors have been retained.

**Table 3.29:** Pattern matrix

| Pattern Matrix[a] | | | |
|---|---|---|---|
| | Factor | | |
| | **1** | **2** | **3** |
| Q24.15 I used computer-based music players (e.g. Winamp, Media Player, etc) | .783 | | |
| Q24.22 I tried to have the latest version of a software programme | .744 | | |
| Q24.1 I used a computer in the home where I grew up | .726 | | |
| Q24.6 I used search engines to search for information | .711 | | |
| Q24.14 I used tools like MS Word, MS Excel or MS Publisher | .703 | | |
| Q24.23 I tried to have the best hardware that I could afford | .659 | | |
| Q24.10 I used a web-based email account to send or receive email | .564 | | |
| Q24.5 I used Internet Messaging (IM) like Yahoo/Windows Messenger or Mxit | .514 | | |
| Q24.2 I used the Internet in the home where I grew up | .403 | .349 | |
| Q24.13 I used a gaming console like Xbox, Playstation or Wii when I grew up | .377 | .322 | |
| Q24.11 I used the web to make phone calls (e.g. Skype) | | .773 | |
| Q24.9 I used the web for banking, online ticketing, and other similar services | | .746 | |
| Q24.18 My teachers required that I use a computer for homework | | .636 | |
| Q24.19 I made use of Torrent services | | .624 | |
| Q24.7 I used the web for playing games | | .590 | |
| Q24.17 I used computers during classes to learn in my subjects | | .552 | .462 |

| Pattern Matrix[a] | | | |
|---|---|---|---|
| | Factor | | |
| | 1 | 2 | 3 |
| | | | |
| Q24.12 I made use of cloud-based services like Google Drive, or Drop Box | | .518 | |
| Q24.8 I accessed educational websites to learn more about my subjects | | .311 | |
| Q24.3 I used a computer in the computer centre at school | .386 | | .591 |
| Q24.4 I used the Internet on a computer at school | | | .552 |
| Q24.16 My teachers made use of computers to create learning materials | .321 | | .415 |

**Extraction Method: Principal Axis Factoring.**
**Rotation Method: Oblimin with Kaiser Normalization.**
**a. Rotation converged in 33 iterations.**

Table 3.29 shows that ten items Q24.15, Q24.22, Q24.1, Q24.6, Q24.14, Q24.23, Q24.10, Q24.5, Q24.2 and Q24.13 – are substantially loaded on Factor 1. Eight items Q24.11, Q24.9, Q24.18, Q24.19, Q24.7, Q24.17, Q24.12 and Q24.8 – are substantially loaded on Factor 2. Three items Q24.3, Q24.4 and Q24.16 – are loaded on Factor 3. Q24.2, Q24.13 and Q24.8 were dropped due to the low loadings and cross loads of these Questions. Table 3.30 summarises the factor items which can now be used as variables for further analysis.

**Table 3.30** Factor items for Question 24.1 - 24.4 (Use of Technology)

| Items | Questions |
|---|---|
| **Factor 1 - basic use of technology** | Q24.15, Q24.22, Q24.1, Q24.6, Q24.14, Q24.23, Q24.10 and Q24.5 |
| **Factor 2 - medium use of technology** | Q24.11, Q24.9, Q24.18, Q24.19, Q24.7, Q24.17, and Q24.12 |
| **Factor 3 - school use** | Q24.3, Q24.4 |

The variables identified will be analysed in Chapter 4.

### 3.10.2 Cronbach Alpha

The reliability analysis was based on the groups of variable themes from the exploratory factor analysis. George and Mallery (2003: 231) suggest the following guidelines for interpreting the coefficient: _>.9 = Excellent, _>.8 = Good, _>.7 = Acceptable, _>.6= Questionable, _>.5 = Poor and _<.5 = Unacceptable. Pallant (2013) concurs that values above .7 are acceptable but values above .8 are preferable. Each group was tested for reliability individually as shown in Table 3.31:

**Table 3.31:** Cronbach Alpha

| Item | Cronbach's Alpha | Number of items | Reliability |
|---|---|---|---|
| **Factor 1 at school** | .826 | 8 | There is a good and reliable inter-item correlation |
| **Factor 2 at school** | .769 | 6 | There is an acceptable inter-item correlation |
| **Factor 3 at school** | .588 | 3 | The Cronbach Alpha value of .588 shows an unacceptable inter-item correlation and will be discarded |
| **Factor 1 at home** | .815 | 8 | There is a good and reliable inter-item correlation |
| **Factor 2 at home** | .749 | 3 | There is an acceptable inter-item correlation |
| **Factor 3 at home** | .696 | 3 | The Cronbach Alpha value of .696 is just below an acceptable inter-item correlation. The number of items which totals 3 could be a contributing factor to the relatively lower co-efficient. This item will be reported on. |
| **Factor 1 teaching** | .837 | 8 | There is a good and reliable inter-item correlation |
| **Factor 1 learning** | .832 | 7 | There is a good and reliable inter-item correlation |
| **Factor 2 learning** | .844 | 6 | There is a good and reliable inter-item correlation |
| **Factor 3 learning** | .765 | 5 | There is an acceptable inter-item correlation |
| **Factor 1 digital literacy** | .882 | 8 | There is a good and reliable inter-item correlation |
| **Factor 2 digital literacy** | .847 | 7 | There is a good and reliable inter-item correlation |
| **Factor 3 digital literacy** | .807 | 3 | There is a good and reliable inter-item correlation |



Only items with a Cronbach alpha of .7 and above are reported on in Chapter 4 with the exception of Factor 3 'at home'.

### 3.11 ETHICAL CONSIDERATIONS

Written permission to conduct the research amongst the students was obtained from the Faculty of Education Ethics Committee at the JCU (Appendix G) and the Research Ethics Committee at the PCU (Appendix H) in 2013.

It was stipulated to the students that the researcher was (1) interested in isolating those factors that may influence their success in the programming modules that they were enrolled for and (2) the information they provided, would be helpful in assisting the university in re-designing their modules to address their needs more accurately, and to develop supporting learning activities that would assist them in becoming successful in their studies.

Certain variables could be perceived as being of a sensitive nature and therefore all data collected was treated as strictly confidential. Only student numbers were used to identify respondents in order to ensure student anonymity and to assist the researcher in obtaining information about their performance in all their modules, which is essential for the research. However, no student numbers were published in the research report. When reporting on the data, only group profiles were created and not individual profiles. Students therefore remained totally anonymous.

Those who participated in the study did so willingly. Students were required to complete consent forms (Appendix A) in which their rights were spelled out, as well as what was expected from them during the research process, therefore completing four programming aptitude tests and a student profile questionnaire. They were told that they had the right to withdraw from participating in the research at any time, without penalty in any form.

All results emanating from the research were made available for scrutiny by respondents and the institution before their publication. All data and artefacts that resulted from the research were archived either electronically or in the form in which they were generated, and are available for a period of time in line with University requirements. Student's names were not captured electronically. The electronic data will be kept for posterity for research purposes only. Students may at any stage of the research request to have their information removed from the dataset.

In all cases, utmost care was taken to ensure that data was collected in a responsible way, and that the data was recorded as accurately as possible. During the data analysis part of the research, the researcher attempted to use measures that ensured the integrity of the analysis by being informed of the appropriate data analysis techniques.

## 3.12 SUMMARY

This chapter discusses the research design and methodology of the study. A student profile questionnaire was developed to gather the students' background information regarding their problem solving, socio-economic status, educational background, performance in school mathematics, English language proficiency, digital literacy and previous programming experience. Various computer programming aptitude tests were also adapted from the University of Kent to determine students' logical reasoning (Appendix C), non-verbal reasoning (Appendix D), numerical reasoning (Appendix E) and verbal logic (Appendix F). The data collected were in relation to the students final marks (dependent variable) for the module Development Software 1 (computer programming) at the JCU and the PCU, to determine those factors (independent variables) that may impact on a student's performance in programming, to assist educational institutions to find ways to overcome the inhibitors that were identified. Matters pertaining to how data was collected and analysed was also discussed as well as reliability, validity and ethical aspects of the study.

In the following chapter the results of the research will be presented.

# CHAPTER 4

# RESULTS

## 4.1 INTRODUCTION

The purpose of this survey research study was to determine whether selected pre-entry attributes could be correlated with a student's performance in DS1 programming modules. In this chapter, the results of the statistical analyses will be presented. Seven null hypotheses were developed. They are presented in Table 4.1.

**Table 4.1**: Null hypotheses

| | Null Hypotheses |
|---|---|
| H01: | There is no relationship between a novice South African programming student's problem solving abilities and their performance in computer programming modules. |
| H02: | There is no relationship between a novice South African programming student's socio-economic status and their performance in computer programming modules. |
| H03: | There is no relationship between a novice South African programming student's educational background and their performance in computer programming modules. |
| H04: | There is no relationship between a novice South African programming student's performance in school mathematics and their performance in computer programming modules. |
| H05: | There is no relationship between a novice South African programming student's performance in English at school level and their performance in computer programming modules. |
| H06: | There is no relationship between a novice South African programming student's digital literacy and their performance in computer programming modules. |
| H07: | There is no relationship between a South African programming student's previous programming experience and their performance in computer programming modules. |



This chapter reports on the results of the analysis that was conducted on the 379 first year programming students at the JCU and the PCU.

## 4.2 ANALYSIS

A combination of descriptive statistics and inferential statistics were used to analyse the quantitative data from the Student Profile Questionnaire and programming aptitude tests. Descriptive statistics were used to disaggregate the data. In order to establish the normality of the data, a visual inspection of the distribution of the data for the dependent variable Development Software 1 final marks was performed by viewing a histogram and generating p-p plots (probability-probability plots). These are represented in Figure 4.1 and Figure 4.2. Figure 4.1 shows a normal distribution of students' final marks for the programming subject Development Software 1 (DS1).

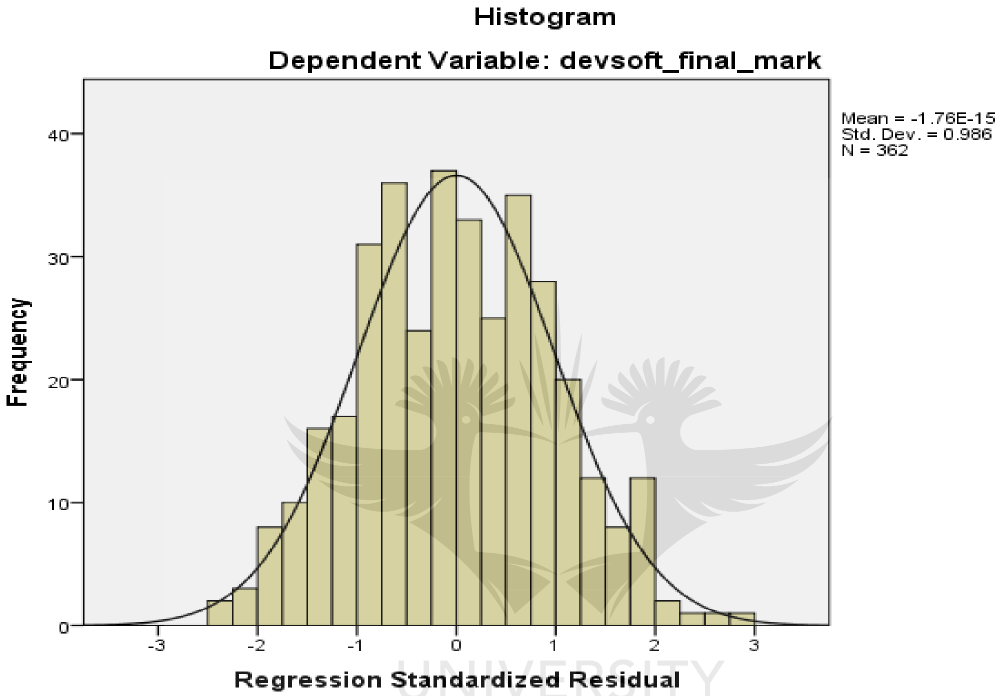



**Figure 4.1:** Dependent variable DS1 histogram

To confirm the assumption that the residuals are normally distributed, the normal p-p plot of regression standardized residual is examined.

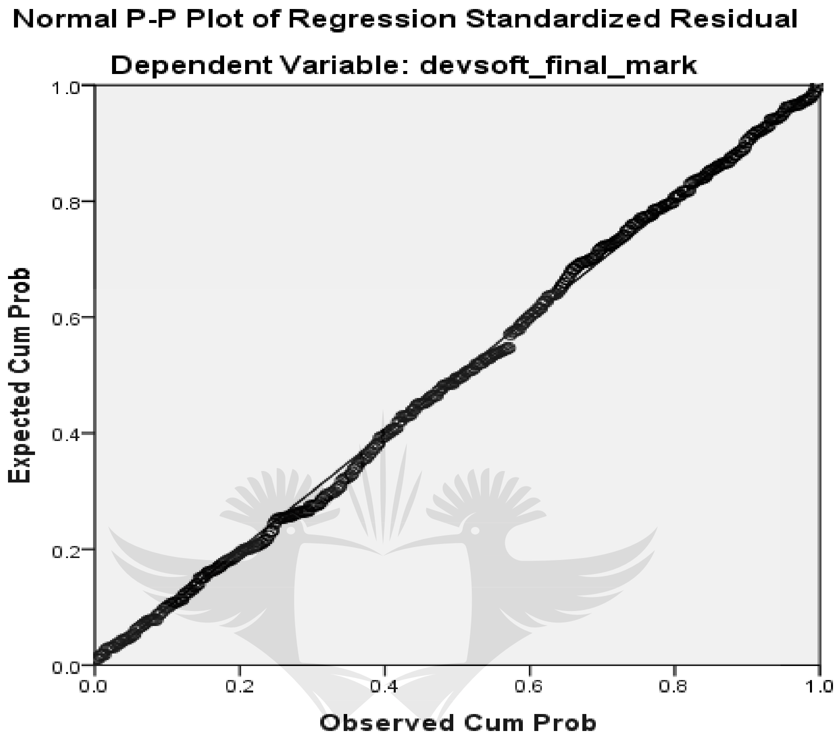



**Figure 4.2:** Dependent variable DS1 normal p-p plot of regression standardized residual

The criteria for normal distribution is the degree to which the plot for the actual values coincides with the line of expected values. Figure 4.2 shows that the plot of residuals fits the expected pattern well enough to support a conclusion that the residuals are normally distributed.

The results will now be presented according to each pre-entry attribute identified as a predictor of students' performance in programming modules.

### 4.2.1 Problem solving ability

The main objective of computer programming is to implement programs that solve computational problems. Reed, Miller and Braught, (2000); Kimmel, Kimmel and Deek, (2003); Muller and Haberman, (2009) predict that problem solving ability is an indicator of programming performance. The four programming aptitude tests for logical reasoning, non-verbal reasoning, numerical reasoning and verbal logic were correlated with the DS1 final mark of the students. The results of the computation are presented in Table 4.2.

**Table 4.2:** Correlation of programming aptitude tests and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Logical Reasoning Test Mark** | Pearson Correlation | .199 |
| | Sig. (2-tailed) | .000 |
| | N | 341 |
| **Non-Verbal Reasoning Test Mark** | Pearson Correlation | .095 |
| | Sig. (2-tailed) | .078 |
| | N | 347 |
| **Numerical Reasoning Test Mark** | Pearson Correlation | .257 |
| | Sig. (2-tailed) | .000 |
| | N | 348 |
| **Verbal Logic Test Mark** | Pearson Correlation | .143 |
| | Sig. (2-tailed) | .008 |
| | N | 341 |



#### Logical Reasoning

A Pearson product-moment correlation coefficient was computed to assess the relationship between the logical reasoning test mark variable and the students' performance in DS1 variable. Logical reasoning refers to a students' ability to think logically and analytically. There was a small, positive correlation between the two variables, $r = .199$, $n = 341$, $p = .000$. Overall, there was a small, positive correlation between the non-verbal reasoning test mark and performance in DS1.

#### Non-Verbal Reasoning Test Mark

A Pearson product-moment correlation coefficient was computed to assess the relationship between the non-verbal reasoning test mark variable and the students' performance in DS1 variable. Non-verbal reasoning refers to a student's ability to understand and analyse visual information and solve problems using visual reasoning. There was no correlation between the two variables, r = .095, n = 347, p = .078. The results show that for this group there is an insignificant correlation between students' non-verbal reasoning ability and performance in DS1.

**Numerical Reasoning Test Mark**

A Pearson product-moment correlation coefficient was computed to assess the relationship between the numerical reasoning test mark variable and the students' performance in DS1 variable. The numerical reasoning test included mathematical questions. There was a small, positive correlation between the two variables, r = .257, n = 348, p = .000. Overall, there was a small, positive correlation between the non-verbal reasoning test mark and performance in DS1.

**Verbal Logic Test Mark**

A Pearson product-moment correlation coefficient was computed to assess the relationship between the verbal logic test mark variable and the students' performance in DS1 variable. The verbal logic test included logical, analytical and numerical questions. There was a small, positive correlation between the two variables, r = .143, n = 341, p = .008. Overall, there was a small, positive correlation between the verbal logic test mark and performance in DS1.

### 4.2.2 Socio-economic status

4.2.2.1 Residential Area

Table 4.3 shows descriptive statistics for the type of residential area in which students grew up, including the dependent variable DS1 for each category of residential area.

**Table 4.3:** DS1 Performance by residential area

| Residential Area | N | Mean marks achieved | Std. Deviation | Range | |
|---|---|---|---|---|---|
| Informal settlement | 19 | 59.316 | 10.9699 | 41.0 | 76.0 |
| Rural village/farm | 118 | 55.958 | 12.1819 | 12.0 | 88.0 |
| Township | 143 | 57.280 | 12.9932 | 13.0 | 84.0 |
| A town | 31 | 58.000 | 12.2147 | 12.0 | 76.0 |
| Suburb in a city | 56 | 60.750 | 13.3215 | 16.0 | 88.0 |
| Other | 9 | 62.000 | 10.0499 | 51.0 | 78.0 |
| Total | 376 | 57.657 | 12.6141 | 12.0 | 88.0 |

According to the Programme for International Student Assessment (PISA), the relationship between student performance and economic, social and cultural status is not deterministic of a student's academic performance (OECD, 2010). Many disadvantaged students, score well above what is predicted as do a proportion of students from privileged home backgrounds, perform below what is predicted. For any group of students with similar backgrounds, there is a considerable range in performance. It is worth noting that 23% of the students studying at the JCU and the PCU come from either towns or suburbs in a city compared to the 74% of students who are from informal settlements, rural villages or townships.

**Table 4.4:** Residential area test of homogeneity of variances

| Test of Homogeneity of Variances | | | |
|---|---|---|---|
| Levene Statistic | df1 | df2 | Sig. |
| .539 | 5 | 370 | .747 |

The p value is .747 which is greater than the α level (0.05), therefore there is little evidence that the variances are not equal and the homogeneity of variance assumption is satisfied.

**Table 4.5:** Residential area ANOVA

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 1122.537 | 5 | 224.507 | 1.419 | .217 |
| Within Groups | 58546.205 | 370 | 158.233 | | |
| Total | 59668.742 | 375 | | | |

A one-way ANOVA was conducted to compare the effect of the type of residential area a student grows up in on performance in DS1. There was no effect of residential area on DS1 performance at the $p<.050$ level for the areas of informal settlement (M=59.31, SD=10.96, N=19), rural village/farm (M=55.95, SD =12.18, N=118), township (M=57.28, SD=12.99, N=143), town (M=58.00, SD=12.21, N=31) and suburb in a city (M=60.75, SD= 13.32, N=56). [(F=1.419, p=.217)].

4.2.2.2 Dwelling

Table 4.6 shows descriptive statistics for the type of dwelling in which students grew up, including the dependent variable DS1 for each category of dwelling.

**Table 4.6:** DS1 Performance by dwelling

| Dwelling | N | Mean marks achieved | Std. Deviation | Range | |
|---|---|---|---|---|---|
| Informal dwelling in an informal squatter settlement or on a farm | 25 | 60.160 | 9.6940 | 45.0 | 78.0 |
| Room/flat on a property or servant's quarters/granny flat | 17 | 55.824 | 14.8544 | 17.0 | 78.0 |
| Traditional dwelling/hut/structure made of traditional materials e.g. mud | 24 | 52.667 | 11.9480 | 19.0 | 79.0 |
| Flat/apartment in a block of flats/cluster house in a complex/townhouse | 33 | 58.121 | 9.5058 | 43.0 | 78.0 |
| House or brick/concrete structure on a separate stand or yard or on a farm | 270 | 57.804 | 13.1393 | 12.0 | 88.0 |
| Other | 3 | 62.667 | 8.9629 | 57.0 | 73.0 |
| Total | 372 | 57.608 | 12.6598 | 12.0 | 88.0 |

**Table 4.7:** Dwelling test of homogeneity of variances

| Test of Homogeneity of Variances | | | |
|---|---|---|---|
| Levene Statistic | df1 | df2 | Sig. |
| 1.125 | 5 | 366 | .346 |

The p value is .346 which is greater than the α level (0.05), there is little evidence that the variances are not equal and the homogeneity of variance assumption is satisfied.

**Table 4.8:** Dwelling ANOVA

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 898.757 | 5 | 179.751 | 1.123 | .347 |
| Within Groups | 58561.942 | 366 | 160.005 | | |
| Total | 59460.699 | 371 | | | |

A one-way ANOVA was conducted to compare the effect of the type of dwelling a student grows up in on performance in DS1. There was no effect of a student's dwelling on DS1 performance at the p<.050 level for Informal dwelling in an informal squatter settlement or on a farm (M=60.16, SD=9.69, N=25), room/flat on a property or servant's quarters/granny flat (M=55.82, SD=14.85, N=17), traditional dwelling/hut/structure made of traditional materials e.g. mud (M=52.66, SD=11.94, N=24), flat/apartment in a block of flats/cluster house in a complex/townhouse (M=58.12, SD=9.50, N=33), house or brick/concrete structure on a separate stand or yard or on a farm (M=57.80, SD=13.13, N=270). [(F=1.123, p=.347)].

4.2.2.3 Level of education – mother or female caregiver

Table 4.9 shows descriptive statistics for the students' mother or female caregiver's level of education, including the dependent variable DS1 for each level.

**Table 4.9:** DS1 Performance by mother or female caregiver's level of education

| Level of Education | N | Mean marks achieved | Std. Deviation | Range | |
|---|---|---|---|---|---|
| Never attended school | 36 | 57.306 | 14.1357 | 12.0 | 76.0 |
| Primary school or high school, but not Std10/Grade 12 | 101 | 57.772 | 12.9591 | 16.0 | 88.0 |
| Grade 12/Senior Certificate | 76 | 56.987 | 13.0461 | 13.0 | 88.0 |
| Post School Certificate/Diploma | 49 | 59.898 | 12.7430 | 12.0 | 84.0 |
| Degree | 38 | 57.842 | 12.2199 | 16.0 | 73.0 |
| Post Graduate Degree | 23 | 57.391 | 10.6205 | 40.0 | 79.0 |
| I don't know | 39 | 57.923 | 9.7559 | 37.0 | 84.0 |
| Not applicable | 9 | 55.889 | 10.9138 | 43.0 | 75.0 |
| Total | 371 | 57.801 | 12.4374 | 12.0 | 88.0 |

Interestingly 37% of students' mothers or female caregivers did not matriculate (N=137) and 11% of students did not know the level of their mother or female caregiver's education (N=39).

**Table 4.10:** Test of homogeneity of variances – mother or female caregiver's level of education

| Test of Homogeneity of Variances | | | |
|---|---|---|---|
| Levene Statistic | df1 | df2 | Sig. |
| .433 | 7 | 363 | .881 |

The p value is .881which is greater than the α level (0.05), there is little evidence that the variances are not equal and the homogeneity of variance assumption is satisfied.

**Table 4.11:** Mother or female caregiver's level of education ANOVA

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 312.173 | 7 | 44.596 | .284 | .960 |
| Within Groups | 56923.067 | 363 | 156.813 | | |
| Total | 57235.240 | 370 | | | |

A one-way ANOVA was conducted to compare the effect of the students' mother or female caregiver's level of education on performance in DS1.

There was no effect of a students' mother or female caregiver's level of education on DS1 performance at the p<.050 level for never attended school (M=57.30, SD=14.13, N=36), primary school or high school, but not Std10/Grade 12 (M=57.72, SD=12.95, N=101), Grade 12/Senior Certificate (M=56.98, SD=13.04, N=76), Post School Certificate/Diploma (M=59.89, SD=12.74, N=49), Degree (M=57.84, SD=12.21, N=38), Post Graduate Degree (M=57.39, SD=10.62, N=23). [(F=.284, p=.960)].

#### 4.2.2.4 Level of education – father or male caregiver

Table 4.12 shows descriptive statistics for the students' father or male caregiver's level of education, including the dependent variable DS1 for each level.

**Table 4.12:** DS1 Performance by father or male caregiver's level of education

| Level of Education | N | Mean marks achieved | Std. Deviation | Range | |
|---|---|---|---|---|---|
| Never attended school | 21 | 54.095 | 16.0652 | 12.0 | 76.0 |
| Primary school or high school, but not Std10/Grade 12 | 86 | 56.791 | 12.8339 | 16.0 | 82.0 |
| Grade 12/Senior Certificate | 57 | 58.439 | 12.4428 | 13.0 | 84.0 |
| Post School Certificate/Diploma | 38 | 57.789 | 15.4817 | 12.0 | 83.0 |
| Degree | 39 | 58.103 | 11.2081 | 37.0 | 88.0 |
| Post Graduate Degree | 21 | 55.857 | 13.8358 | 18.0 | 88.0 |
| I don't know | 62 | 58.210 | 12.3556 | 17.0 | 84.0 |
| Not applicable | 20 | 61.150 | 9.6806 | 48.0 | 79.0 |
| Total | 344 | 57.610 | 12.9024 | 12.0 | 88.0 |

Interestingly 32% of students' fathers or male caregivers did not have a matric (N=107) and 18% of students did not know the level of the father or male caregiver's education (N=62).

**Table 4.13:** Test of homogeneity of variances – father or male caregiver's level of education

| Test of Homogeneity of Variances | | | |
|---|---|---|---|
| Levene Statistic | df1 | df2 | Sig. |
| .782 | 7 | 336 | .603 |

The p value is .603 which is greater than the α level (0.05), there is little evidence that the variances are not equal and the homogeneity of variance assumption is satisfied.

**Table 4.14:** Father or male caregiver's level of education ANOVA

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 704.424 | 7 | 100.632 | .600 | .756 |
| Within Groups | 56395.378 | 336 | 167.843 | | |
| Total | 57099.802 | 343 | | | |

A one-way ANOVA was conducted to compare the effect of the students' father or male caregiver's level of education on performance in DS1. There was no effect of a students' father or male caregiver's level of education on DS1 performance at the p<.050 level for never attended school (M=54.09, SD=16.06, N=21), primary school or high school, but not Std10/Grade 12 (M=56.79, SD=12.83, N=86), Grade 12/Senior Certificate (M=58.43, SD=12.44, N=57), Post School Certificate/Diploma (M=57.78, SD=15.48, N=38), Degree (M=58.10, SD=11.20, N=39), Post Graduate Degree (M=55.85, SD=13.83, N=21). [(F=.600, p=.756)].

4.2.2.5 Employment status – mother or female caregiver

Table 4.15 shows descriptive statistics for the students' mother or female caregiver's employment status, including the dependent variable DS1 for each status.

**Table 4.15:** DS1 Performance by mother or female caregiver's employment status

| Employment Status | N | Mean marks achieved | Std. Deviation | Range | |
|---|---|---|---|---|---|
| Currently unemployed | 123 | 56.732 | 12.6770 | 12.0 | 80.0 |
| Retired | 12 | 60.167 | 8.3103 | 46.0 | 76.0 |
| Informally employed e.g. piece job | 17 | 57.471 | 11.9432 | 34.0 | 76.0 |
| Unskilled labour | 23 | 53.000 | 15.3534 | 16.0 | 88.0 |
| Skilled labour e.g. mechanic | 5 | 61.200 | 9.7314 | 50.0 | 73.0 |
| Retail/Services/Government/Local Government | 47 | 61.723 | 10.7394 | 37.0 | 88.0 |
| Professional e.g. teacher/lawyer/accountant | 56 | 58.321 | 12.3054 | 16.0 | 83.0 |
| Entrepreneur/business owner | 17 | 60.647 | 10.5649 | 43.0 | 79.0 |
| Not applicable | 29 | 59.345 | 15.1782 | 12.0 | 84.0 |
| Unsure | 9 | 54.667 | 19.4036 | 18.0 | 75.0 |
| Other | 9 | 56.667 | 9.9624 | 40.0 | 69.0 |
| Total | 347 | 57.991 | 12.6901 | 12.0 | 88.0 |

Parental occupational status, which is often closely interrelated with other attributes of socio-economic status, has a strong association with student performance according to the Organisation for Economic Co-operation and Development (OECD, 2004). Interestingly, 35% of students' mothers or female caregivers are unemployed (N=123).

**Table 4.16:** Test of homogeneity of variances – mother or female caregiver's employment status

| Test of Homogeneity of Variances | | | |
|---|---|---|---|
| Levene Statistic | df1 | df2 | Sig. |
| 1.023 | 10 | 336 | .423 |

The p value is .423 which is greater than the α level (0.05), there is little evidence that the variances are not equal and the homogeneity of variance assumption is satisfied.

**Table 4.17:** Mother or female caregiver's employment status ANOVA

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 1830.073 | 10 | 183.007 | 1.141 | .331 |
| Within Groups | 53888.901 | 336 | 160.384 | | |
| Total | 55718.974 | 346 | | | |

A one-way ANOVA was conducted to compare the effect of the students' mother or female caregiver's employment status on performance in DS1. There was no effect of a students' mother or female caregiver's employment status on DS1 performance at the p<.050 level for currently unemployed (M=56.73, SD=12.67, N=123), retired (M=60.16, SD=8.31, N=12), informally employed e.g. piece job (M=57.47, SD=11.94, N=17) unskilled labour (M=53.00, SD=15.35, N=23), skilled labour e.g. mechanic (M=61.20, SD=9.73, N=5) retail/services/government/local government (M=61.72, SD=10.73, N=47), professional e.g. teacher/lawyer/accountant (M=58.32, SD=12.30, N=56), entrepreneur/business owner (M=60.64, SD=10.56, N=17). ). [(F=1.141, p=.331)].

#### 4.2.2.6 Employment status – father or male caregiver

Table 4.18 shows descriptive statistics for the students' father or male caregiver's employment status, including the dependent variable DS1 for each status.

**Table 4.18:** DS1 Performance by father or male caregiver's employment status

| Employment Status | N | Mean marks achieved | Std. Deviation | Range | |
|---|---|---|---|---|---|
| Currently unemployed | 49 | 57.306 | 12.4920 | 12.0 | 79.0 |
| Retired | 26 | 56.000 | 13.8968 | 18.0 | 84.0 |
| Informally employed e.g. piece job | 10 | 53.800 | 15.6759 | 16.0 | 76.0 |
| Unskilled labour | 11 | 51.364 | 9.1353 | 37.0 | 67.0 |
| Skilled labour e.g. mechanic | 21 | 60.905 | 11.4451 | 35.0 | 78.0 |
| Retail/Services/ Government/Local Government | 50 | 57.980 | 11.7169 | 16.0 | 88.0 |
| Professional e.g. teacher/lawyer/ accountant | 42 | 57.143 | 11.5517 | 37.0 | 78.0 |
| Entrepreneur/business owner | 21 | 60.810 | 15.8007 | 12.0 | 88.0 |
| Not applicable | 43 | 60.791 | 13.0741 | 30.0 | 84.0 |
| Unsure | 29 | 57.172 | 14.8542 | 17.0 | 78.0 |
| Other | 14 | 56.929 | 16.5086 | 13.0 | 80.0 |
| Total | 316 | 57.883 | 13.0451 | 12.0 | 88.0 |

A high percentage (16%) of students fathers or male caregivers are unemployed (N=49). According to the latest reports, South Africa’s unemployment rate is 24.3% (Trading Economics.com[a], 2015).

**Table 4.19:** Test of homogeneity of variances – father or male caregiver’s employment status

| Test of Homogeneity of Variances | | | |
|---|---|---|---|
| Levene Statistic | df1 | df2 | Sig. |
| .536 | 10 | 305 | .864 |

The p value is .864 which is greater than the α level (0.05), there is little evidence that the variances are not equal and the homogeneity of variance assumption is satisfied.

**Table 4.20:** Father or male caregiver’s employment status ANOVA

| ANOVA | | | | | |
|---|---|---|---|---|---|
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 1528.761 | 10 | 152.876 | .895 | .538 |
| Within Groups | 52075.907 | 305 | 170.741 | | |
| Total | 53604.668 | 315 | | | |

A one-way ANOVA was conducted to compare the effect of the students’ father or male caregiver’s employment status on performance in DS1. There was no effect of a students’ father or male caregiver’s employment status on DS1 performance at the p<.050 level for currently unemployed (M=57,30, SD=12.49, N=49), retired (M=56.00, SD=13.89, N=26), informally employed e.g. piece job (M=53.80, SD=15.67, N=10) unskilled labour (M=51.36, SD=9.13, N=11), skilled labour e.g. mechanic (M=60.90, SD=11.44, N=21 retail/services/government/local government (M=57.98, SD=11.71, N=50), professional e.g. teacher/lawyer/accountant (M=57.14, SD=11.55, N=42), entrepreneur/business owner (M=60.81, SD=15.80, N=21). [(F=.895, p=.538)].

### 4.2.3 Educational background

#### 4.2.3.1 Critical thinking (at school and at home)

The subscale contained items that attempted to establish the extent to which students believed that their critical thinking skills were being developed at school and at home.

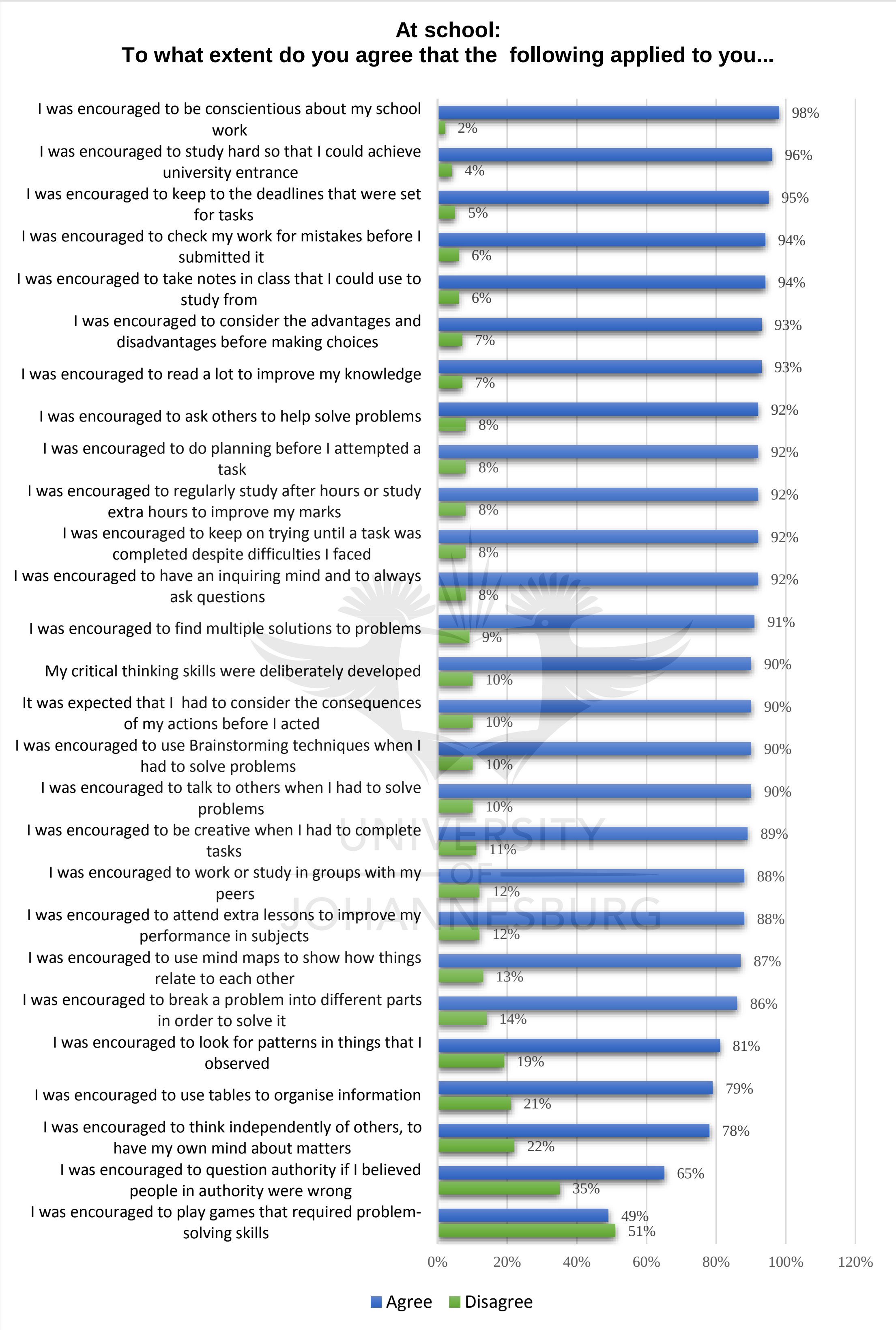



**Figure 4.3:** Critical thinking skills encouraged at school

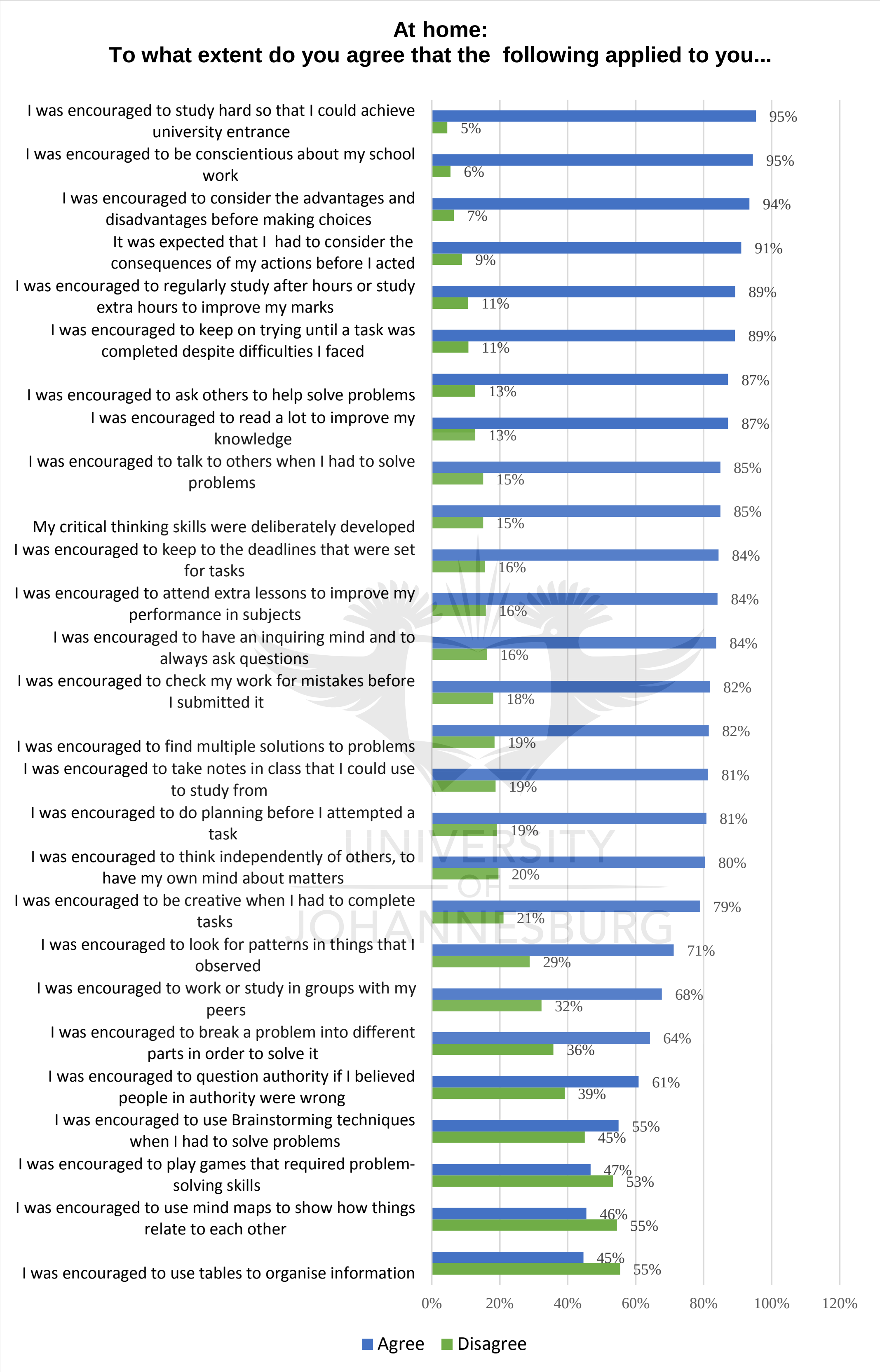



**Figure 4.4:** Critical thinking skills encouraged at home

The results in Figure 4.4 show children are encourage to be critical thinkers at home but not on the same level as at school as shown in Figures 4.5a and 4.5b.

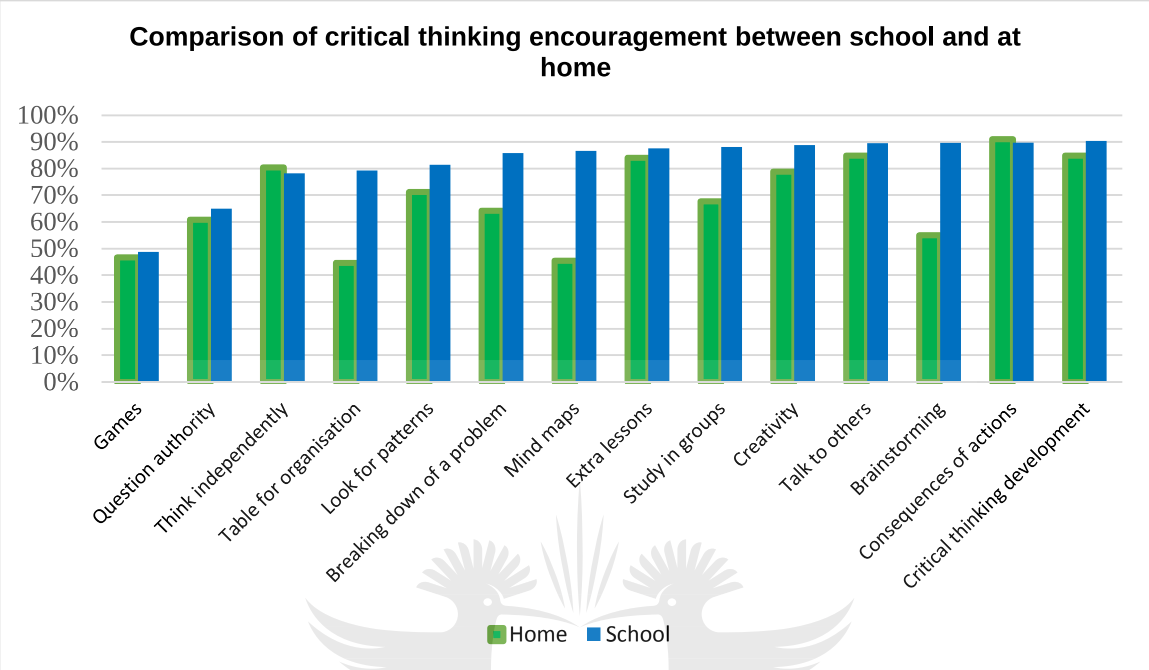



**Figure 4.5a:** Comparison of critical thinking encouragement between school and at home

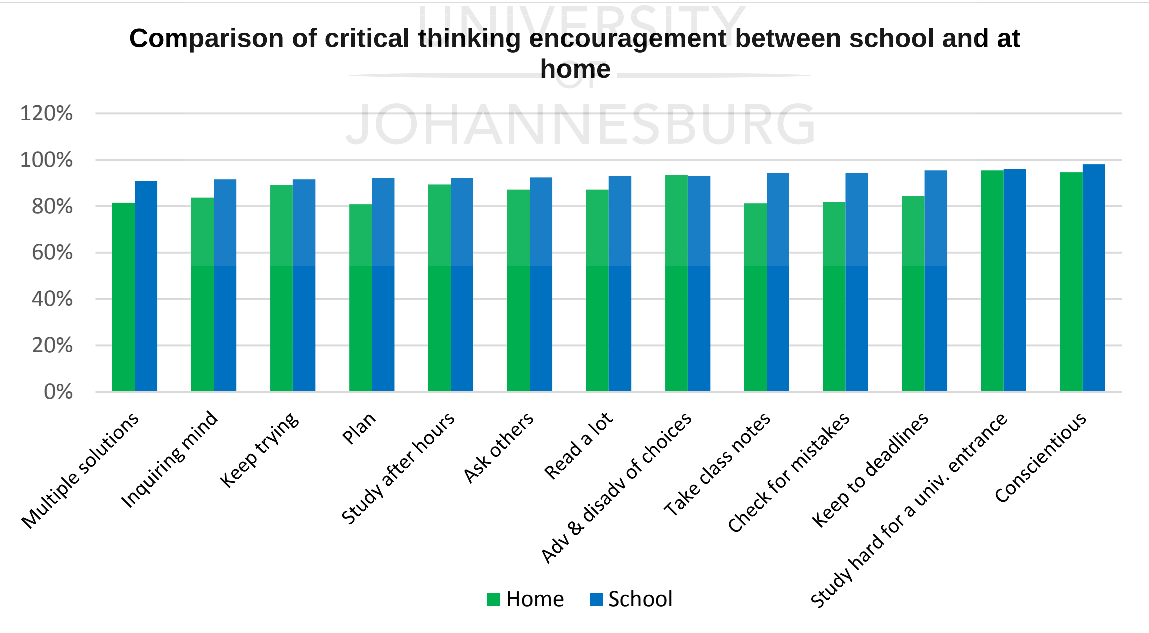



**Figure 4.5b:** Comparison of critical thinking encouragement between school and at home (cont.)

In order to statistically determine critical thinking encouragement that happened at school and at home, an exploratory factor analysis was used to identify different items in Chapter 3 (see 3.10.1.1 and 3.10.1.2). The critical thinking factors identified at school were: Factor 1 = encouraged to develop good study habits, Factor 2 = encouraged to analyse ones work, Factor 3 = encouraged to think independently. Factor 3 was discarded due to the Cronbach Alpha value being 5.88 an unacceptable inter-item correlation according to George and Mallery (2003: 231). The relationships and patterns within each remaining item was then correlated with the dependent variable DS1 mark.

**Table 4.21:** Correlation of critical thinking items at school and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Factor 1 (at school) - encouraged to develop good study habits** | Pearson Correlation | -.098 |
| | Sig. (2-tailed) | .057 |
| | N | 376 |
| **Factor 2 (at school) - encouraged to analyse ones work** | Pearson Correlation | .000 |
| | Sig. (2-tailed) | .996 |
| | N | 377 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 1: encouraged to develop good study habits variable and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.098, n = 376, p = .057. The results show that for this group there is an insignificant correlation between students' who were encouraged to develop good study habits and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 2: encouraged to analyse ones work variable and the students' performance in DS1 variable. There was no correlation between the two variables, r = .000, n = 377, p = .996. The results show that for this group there is an insignificant correlation between students' who were encouraged to analyse their work at school and performance in DS1.

The critical thinking factors identified at home were: Factor 1 = encouraged to develop higher order thinking skills, Factor 2 = encouraged to do additional work, Factor 3 = encouraged to recognize the structure of content. The relationships and patterns within each remaining item was then correlated with the dependent variable DS1 mark.

**Table 4.22:** Correlation of critical thinking items at home and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Factor 1 (at home) – encouraged to develop higher order thinking skills** | Pearson Correlation | -.093 |
| | Sig. (2-tailed) | .075 |
| | N | 366 |
| **Factor 2 (at home) – encouraged to do additional work** | Pearson Correlation | -.022 |
| | Sig. (2-tailed) | .668 |
| | N | 370 |
| **Factor 3 (at home) – encouraged to recognize the structure of content** | Pearson Correlation | -.045 |
| | Sig. (2-tailed) | .395 |
| | N | 362 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 1: encouraged to develop higher order thinking skills and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.093, n = 366, p = .075. The results show that for this group there is an insignificant correlation between students' who were encouraged to develop higher order thinking skills at home and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 2: encouraged to do additional work and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.022, n = 370, p = .668. The results show that for this group there is an insignificant correlation between students' who were encouraged to do additional work at home and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 3: encouraged to recognize the structure of content and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.045, n = 362, p = .395. The results show that for this group there is an insignificant correlation between students' who were encouraged to recognize the structure of content at home and performance in DS1.

#### 4.2.3.2 Teaching style

When students were asked how they were taught at school by their teachers, they responded as follows:

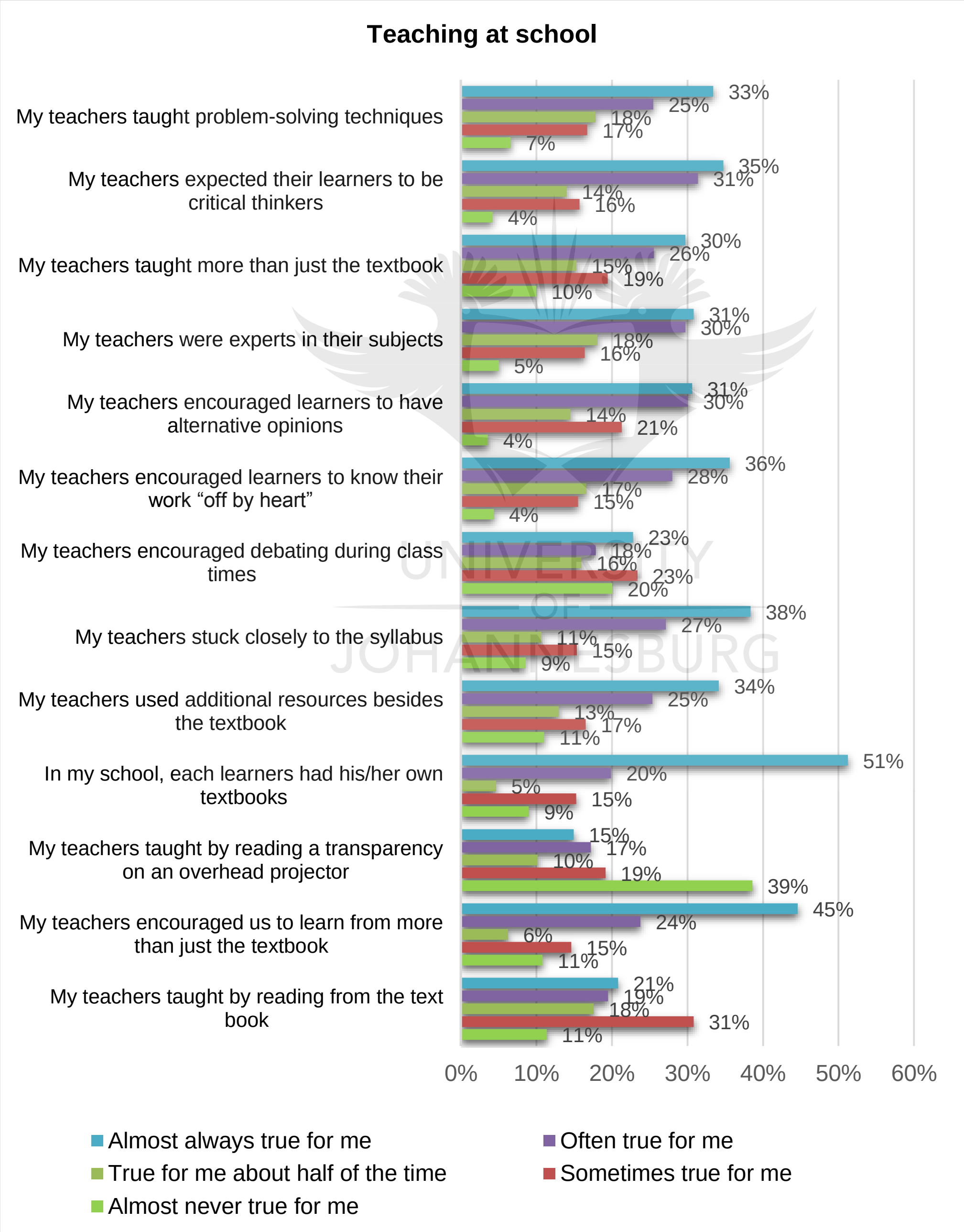



**Figure 4.6a:** Teaching received at school

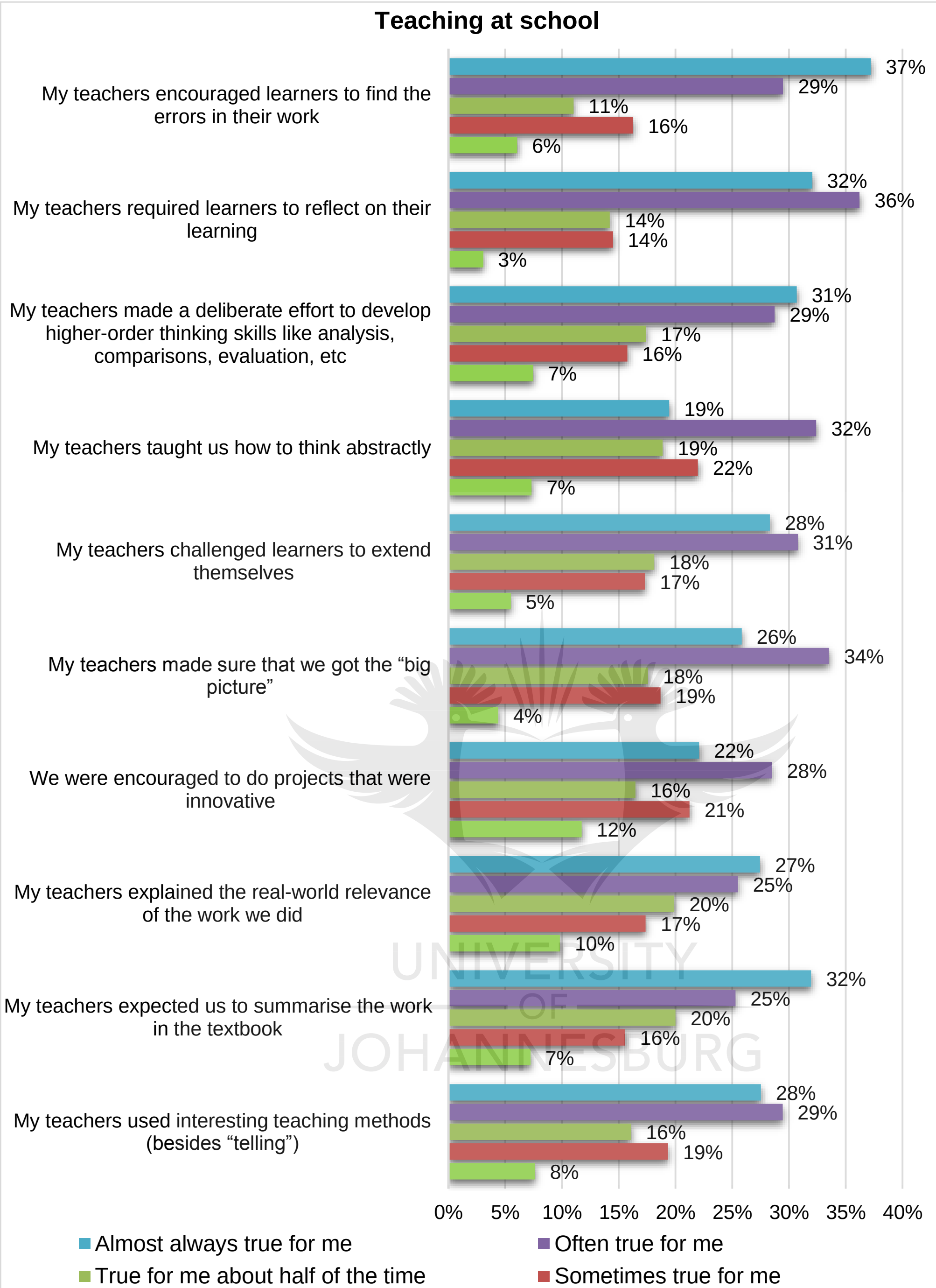



**Figure 4.6b:** Teaching received at school (cont.)

In order to determine what type of teaching students received at school, an exploratory factor analysis was used to identify different items in Chapter 3 (see 3.10.1.3). Only one item was identified namely constructive teaching. The relationship and pattern within this item was then correlated with the dependent variable DS1 mark.

**Table 4.23:** Correlation of teaching received at school and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Factor 1 (teaching) – constructive teaching** | Pearson Correlation | -.016 |
| | Sig. (2-tailed) | .752 |
| | N | 374 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 1: constructive teaching and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.016, n = 374, p = .752. The results show that for this group there is an insignificant correlation between the type of teaching students received at school and performance in DS1.

#### 4.2.3.3 Self-regulated learning

Self-regulated learning is a process that assists students to better manage their thoughts, their behaviour and emotions with the aim to successfully navigate their learning experiences (Zumbrunn & Tadlock & Robert, 2011). This is recognised as an important predictor to academic motivation and achievement of the students enrolled in academic courses (Zimmerman *et al*, 1992). When students were asked how they learnt at school, they responded as follows:

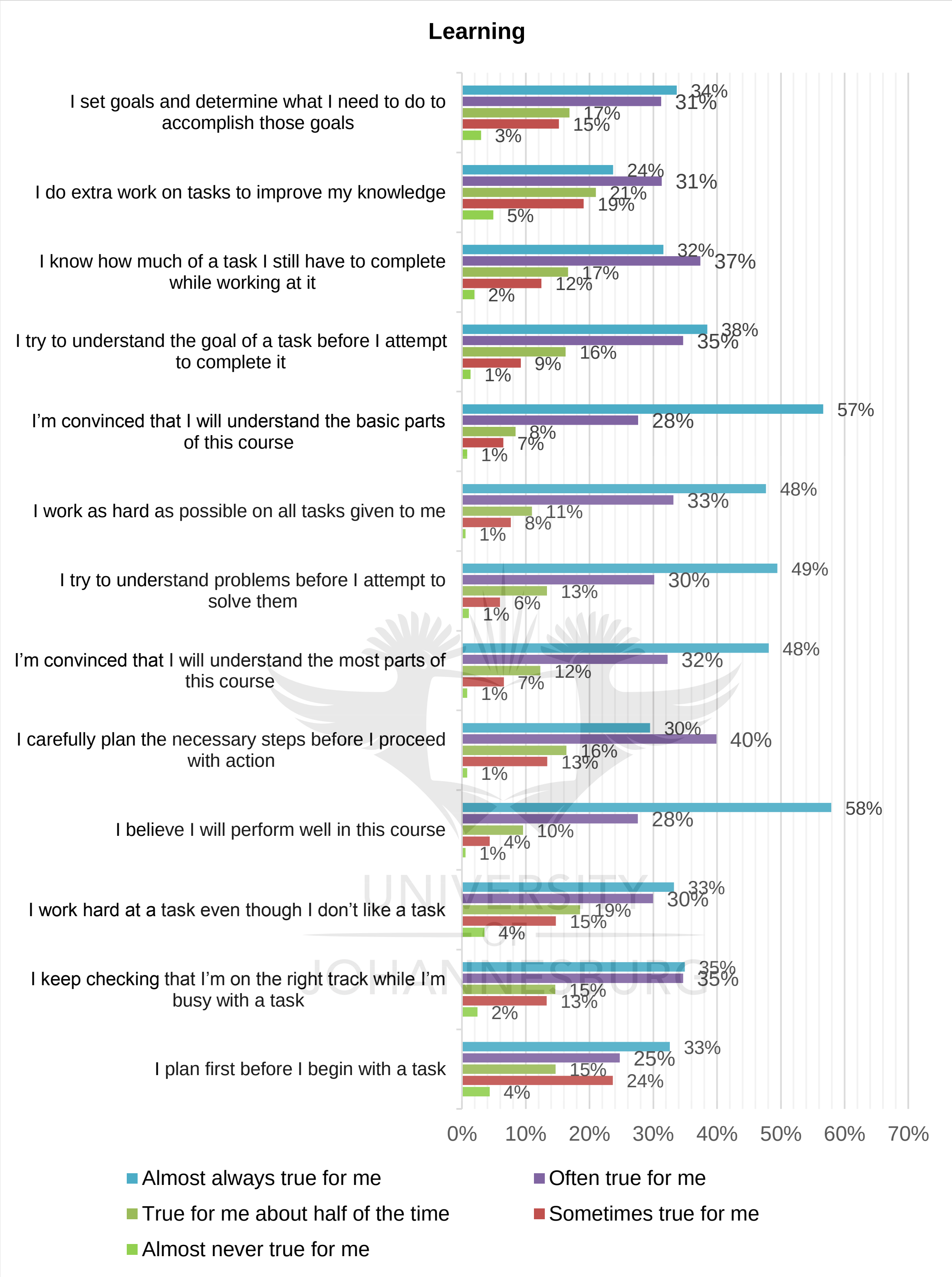



**Figure 4.7a:** Student self-regulation

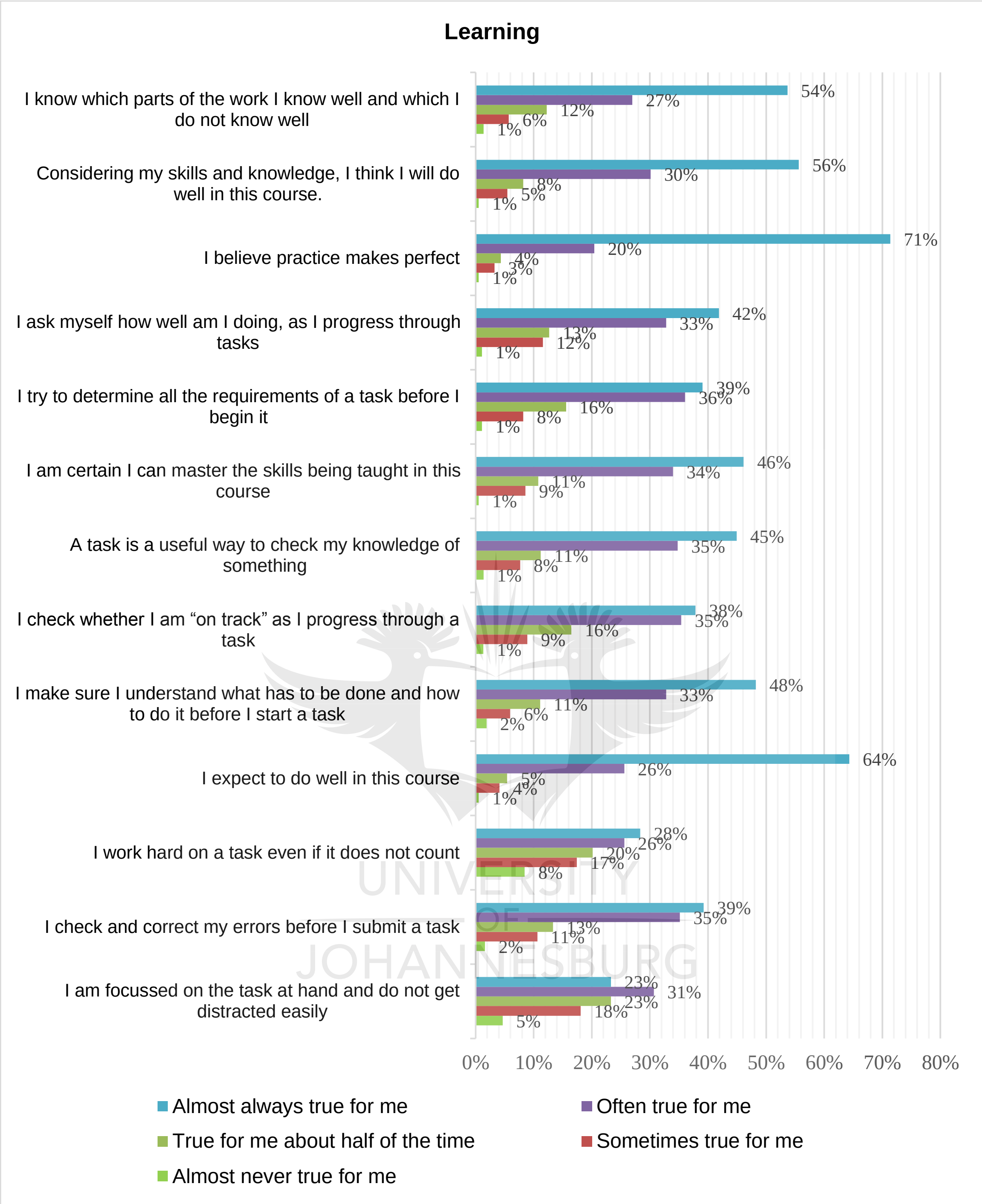



**Figure 4.7b:** Student self-regulation (cont.)

Figure 4.7a and Figure 4.7b indicate that the majority of students regulate their own learning experiences. In order to determine which self-regulated learning traits correlated with a student’s success in their DS1 mark, exploratory factor analysis was used to identify different items in Chapter 3 (see 3.10.1.4).

The self-regulation factors identified at school were: Factor 1 = metacognitive ability, Factor 2 = self-efficacy, Factor 3 = motivation to learn. The relationships and patterns within each item was then correlated with the dependent variable DS1 mark.

**Table 4.24:** Correlation of learning and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Factor 1 (self-regulated learning) metacognitive ability** | Pearson Correlation | -.022 |
| | Sig. (2-tailed) | .669 |
| | N | 370 |
| **Factor 2 (self-regulated learning) self-efficacy** | Pearson Correlation | .055 |
| | Sig. (2-tailed) | .292 |
| | N | 370 |
| **Factor 3 (self-regulated learning) motivation to learn** | Pearson Correlation | -.119 |
| | Sig. (2-tailed) | .022 |
| | N | 370 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 1: metacognitive ability and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.022, n = 370, p = .669. The results show that for this group there is an insignificant correlation between the students' metacognitive ability and performance in DS1.



A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 2: self-efficacy and the students' performance in DS1 variable. There was no correlation between the two variables, r = .055, n = 370, p = .292. The results show that for this group there is an insignificant correlation between the students' self-efficacy and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 3: motivation to learn and the students' performance in DS1 variable. There was a medium, negative correlation between the two variables, r = -.119, n = 370, p = .022. Overall, there was a small inverse correlation between the students' motivation to learn and performance in DS1.

4.2.3.4 Hours spent studying

Students were then asked how many hours they spent on homework and studying at school.

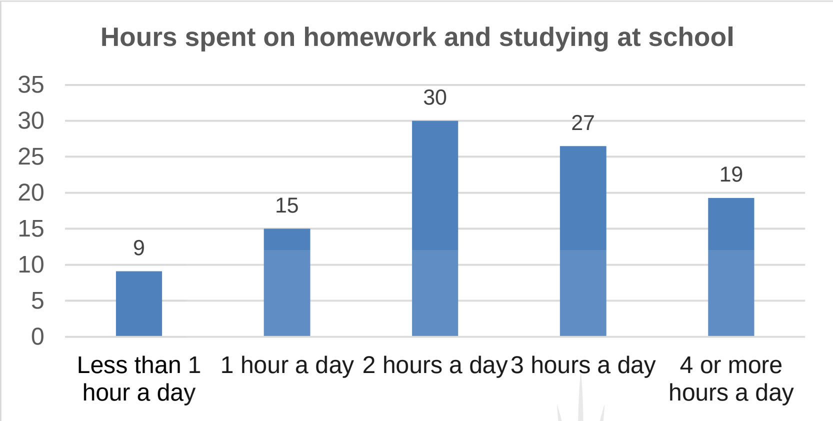



**Figure 4.8:** Hours spent on homework and studying at school



Figure 4.8 shows that 9% of students spent less than one hour a day studying, 15% spent one hour a day studying, the majority of students (30%) spent two hours a day studying, 27% studied three hours a day and 19% studied four hours a day or more. Students were then asked how many hours a day they planned on studying at university.

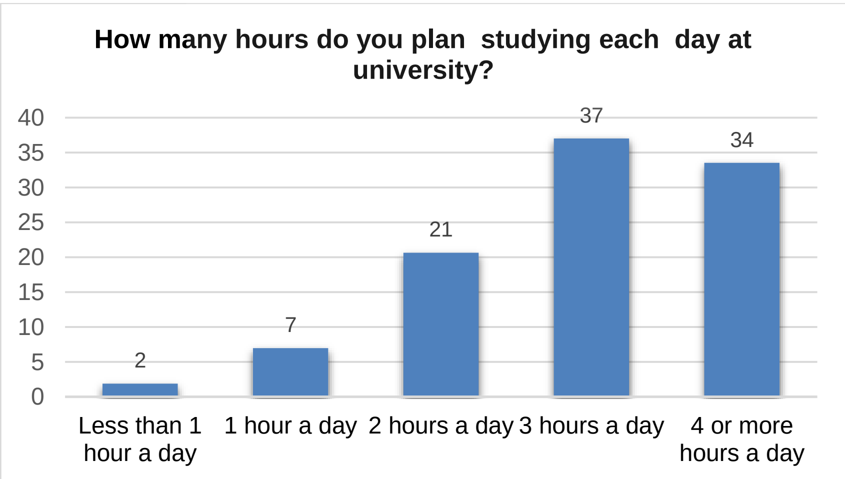



**Figure 4.9:** Hours planned studying at university

Figure 4.9 shows that the majority of students planned to put in more hours at university than they did at school with 71% of students planning on studying three or more hours per day.

**Table 4.25:** Correlation of hours planned studying at university and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Q14 How much time are you planning on studying every day (exclude classes, practicals and tutorials).** | Pearson Correlation | -.028 |
| | Sig. (2-tailed) | .587 |
| | N | 373 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between how much time students planned on studying at university and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.028, n = 373, p = .587. The results show that for this group there is an insignificant correlation between the amount of time students planned on studying at university and performance in DS1.

### 4.2.4 Performance in school mathematics

Several studies show that a positive relationship exists between performance in mathematics and success in computer programming courses (Byrne & Lyons, 2001; Wilson & Shrock, 2001; Gomes & Mendes, 2008; Bergin & Reilly, 2005).



**Table 4.26:** Grade 12 performance in Mathematics/ Mathematical Literacy/ National Senior Certificate Mathematics

| Grade 12 performance in Mathematics/Mathematical Literacy | | | | |
|---|---|---|---|---|
| | N | Mean | Median | Std. Deviation |
| **Maths literacy** | 78 | 58.628 | 59.000 | 14.4124 |
| **Mathematics** | 196 | 57.740 | 57.000 | 10.2005 |
| **Maths NCS/NCV** | 90 | 58.222 | 60.000 | 15.3636 |
| **Total** | 364 | 58.049 | 58.000 | 12.5682 |

Table 4.26 shows that the majority of students chose Mathematics (N=196) over Mathematical Literacy (N=78) as a Grade 12 subject. It also shows mean performances for the respective mathematics subjects.

**Table 4.27:** Correlation of Grade 12 Mathematics/ Mathematical Literacy/ National Senior Certificate Mathematics mark and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Grade 12 Mathematics** | Pearson Correlation | -.126 |
| | Sig. (2-tailed) | .079 |
| | N | 196 |
| **Grade 12 Mathematical Literacy** | Pearson Correlation | .282 |
| | Sig. (2-tailed) | .012 |
| | N | 78 |
| **National Senior Certificate Mathematics** | Pearson Correlation | .139 |
| | Sig. (2-tailed) | .192 |
| | N | 90 |

### Grade 12 Mathematics

A Pearson product-moment correlation coefficient was computed to assess the relationship between a student's Grade 12 mathematics mark variable and the students' performance in DS1 variable. There was no correlation between the two variables, r = -.126, n = 196, p = .079. The results show that for this group there is an insignificant correlation between a student's Grade 12 mathematics mark and performance in DS1.

### Grade 12 Mathematical literacy

A Pearson product-moment correlation coefficient was computed to assess the relationship between the student's Grade 12 mathematical literacy mark variable and performance in DS1 variable. There was a small, positive correlation between the two variables, r = .282, n = 78, p = .012. Overall, there was a small, positive correlation between the student's Grade 12 mathematical literacy mark and performance in DS1.

**National Senior Certificate Mathematics**

A Pearson product-moment correlation coefficient was computed to assess the relationship between a student's National Senior Certificate mathematics mark variable and the students' performance in DS1 variable. There was no correlation between the two variables, $r = .139$, $n = 90$, $p = .192$. The results show that for this group there is an insignificant correlation between a student's National Senior Certificate mathematics mark and performance in DS1.

### 4.2.5 Performance in school English

Language and academic success are deemed to be closely related (Leibowitz, 2004). When students were asked if their English ability prevented them from performing well academically they responded as follows:

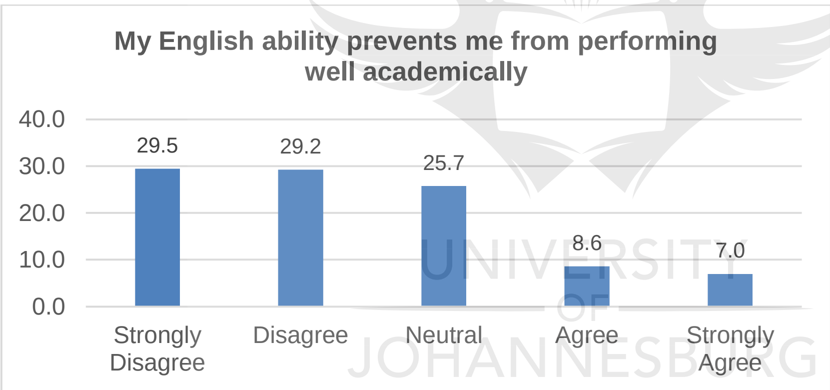



**Figure 4.10:** English ability effects on academic performance

Figure 4.10 shows that 15.6% of students either agreed (8.6%) or strongly agreed (7%) that their English ability prevented them from performing well academically. 58.7% of students either disagreed (29.2%) or strongly disagreed (29.5%) that their English ability prevented them from performing well academically. The remaining students neither agreed nor disagreed.

**Table 4.28:** Correlation of English Grade 12 mark and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Grade 12 English mark** | Pearson Correlation | .081 |
| | Sig. (2-tailed) | .131 |
| | N | 348 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between a student's Grade 12 English mark variable and performance in DS1 variable. There was no correlation between the two variables, r = .081, n = 348, p = .131. The results show that for this group there is an insignificant correlation between a student's Grade 12 English mark and performance in DS1.

### 4.2.6 Digital literacy

As discussed in the literature review there was no literature found on whether digital literacy affects a student's performance in computer programming modules.
When students were asked what types of technology they owned, they responded as follows:

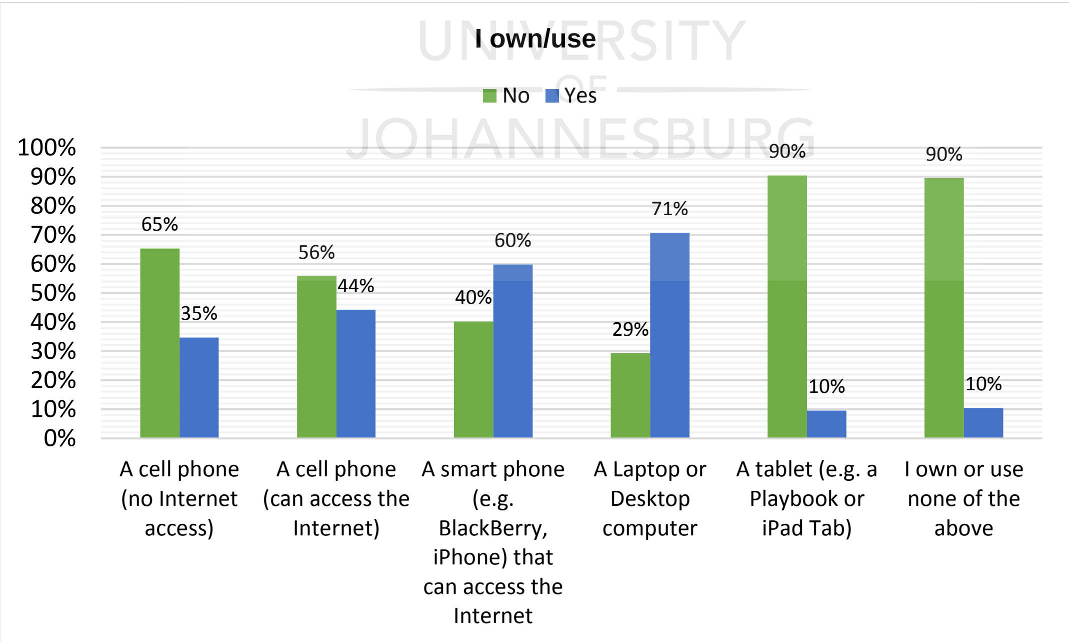



**Figure 4.11:** Technology owned by students

Figure 4.11 shows that 35% of students owned a cell phone with no Internet access, 44% owned a cell phone with Internet access and 60% owned a smart phone with Internet access. 71% of students owned either a laptop or desktop computer and 10% owned a tablet. 10% of students do not own a cell phone, laptop, desktop or tablet.

When students' were asked how much experience they had with computers they responded as follows:

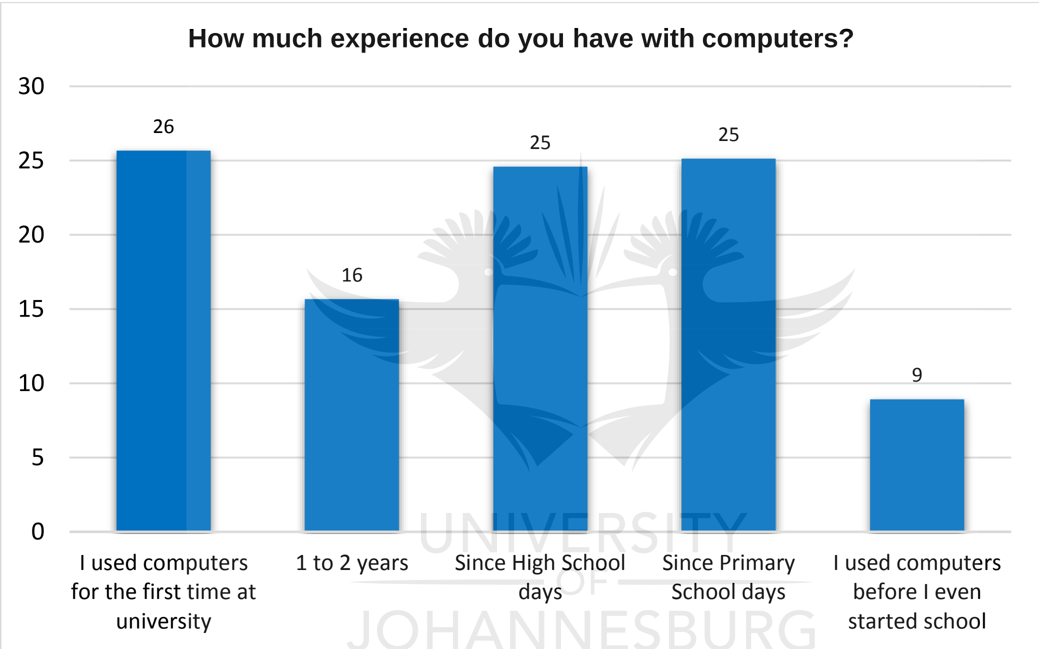



**Figure 4.12:** Computer experience

Figure 4.12 shows that 26% of students used a computer for the first time at University, 16% of students had 1 to 2 years computer experience and 25% had been using a computer since they were in High School. Only 25% of students had been using a computer since they were in primary school and 9% since before they even started school.

**Table 4.29:** Correlation of computer experience and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Q20 How much experience do you have with computers?** | Pearson Correlation | .155 |
| | Sig. (2-tailed) | .003 |
| | N | 370 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between the students' computer experience variable and performance in DS1 variable. There was a small, positive correlation between the two variables, r = .155, n = 370, p = .003. Overall, there was a small, positive correlation between the amount of computer experience a student had and performance in DS1.

When students were asked how many computers they had access to in their homes while growing up, they responded as follows:

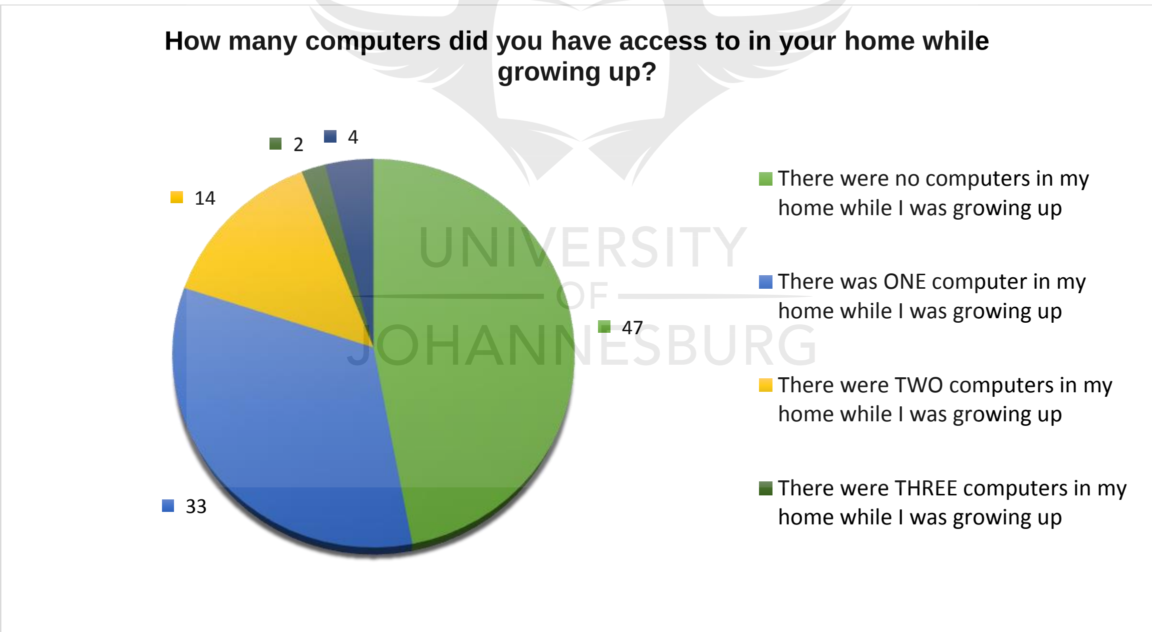



**Figure 4.13:** Number of computers students had access to in their home while growing up

Figure 4.13 shows that 47% of students did not have access to a computer at home while growing up, 33% had access to one computer at home, 14% had access to two computers at home, 2% had access to three computers at home and 4% had one computer for each member of the family.

**Table 4.30:** Correlation of the number of computers students had access to in their home while growing up and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Q23 How many computers did you have access to in your home while growing up?** | Pearson Correlation | .149 |
| | Sig. (2-tailed) | .004 |
| | N | 369 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between the numbers of computers students had access to in their home while growing up variable and performance in DS1 variable. There was a small, positive correlation between the two variables, $r = .149$, $n = 369$, $p = .004$. Overall, there was a small, positive correlation between the number of computers students had access to in their home while growing up and performance in DS1.

Students were then asked how often they used certain types of technology before embarking on their studies at university.

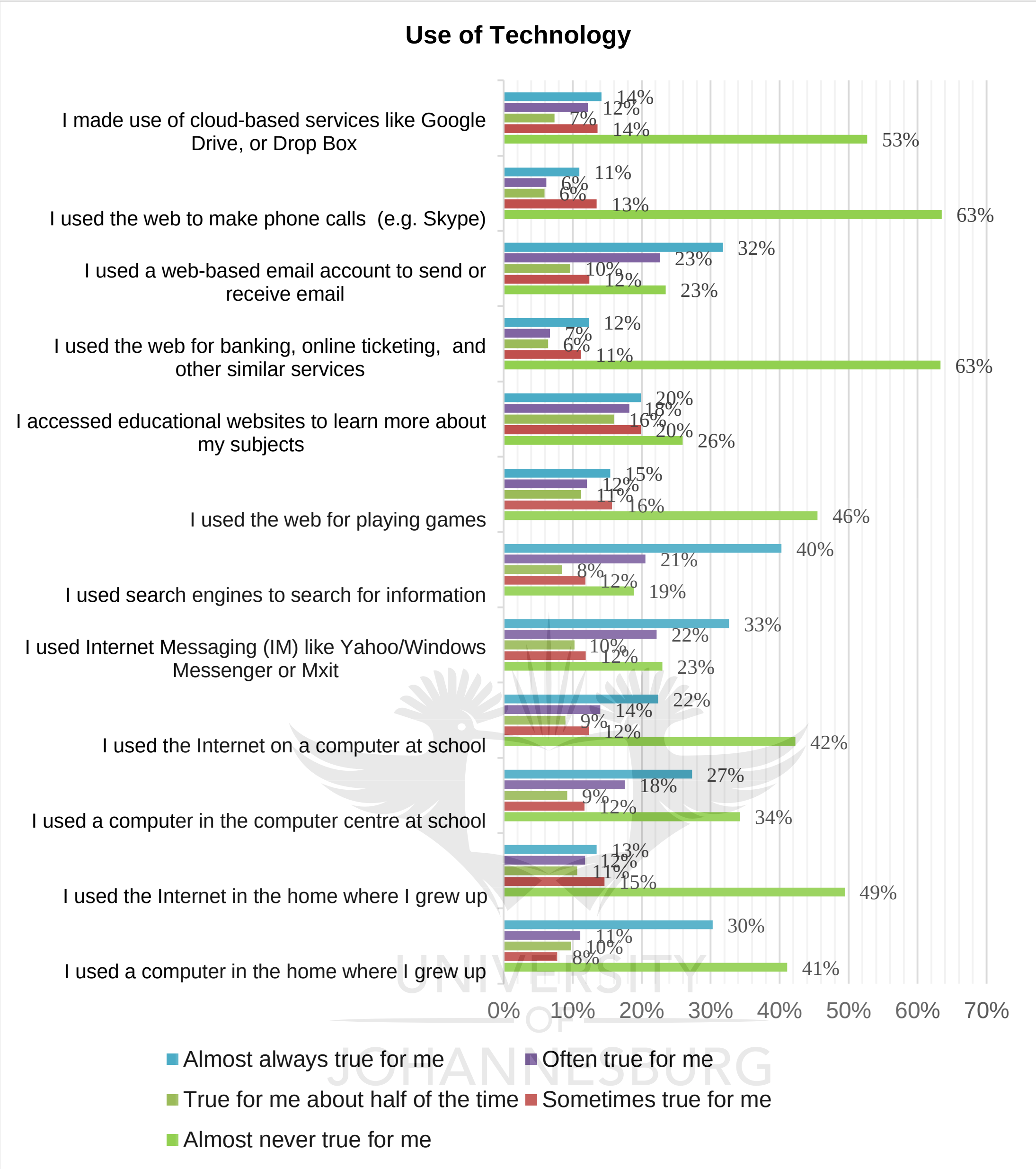



**Figure 4.14a:** Use of technology

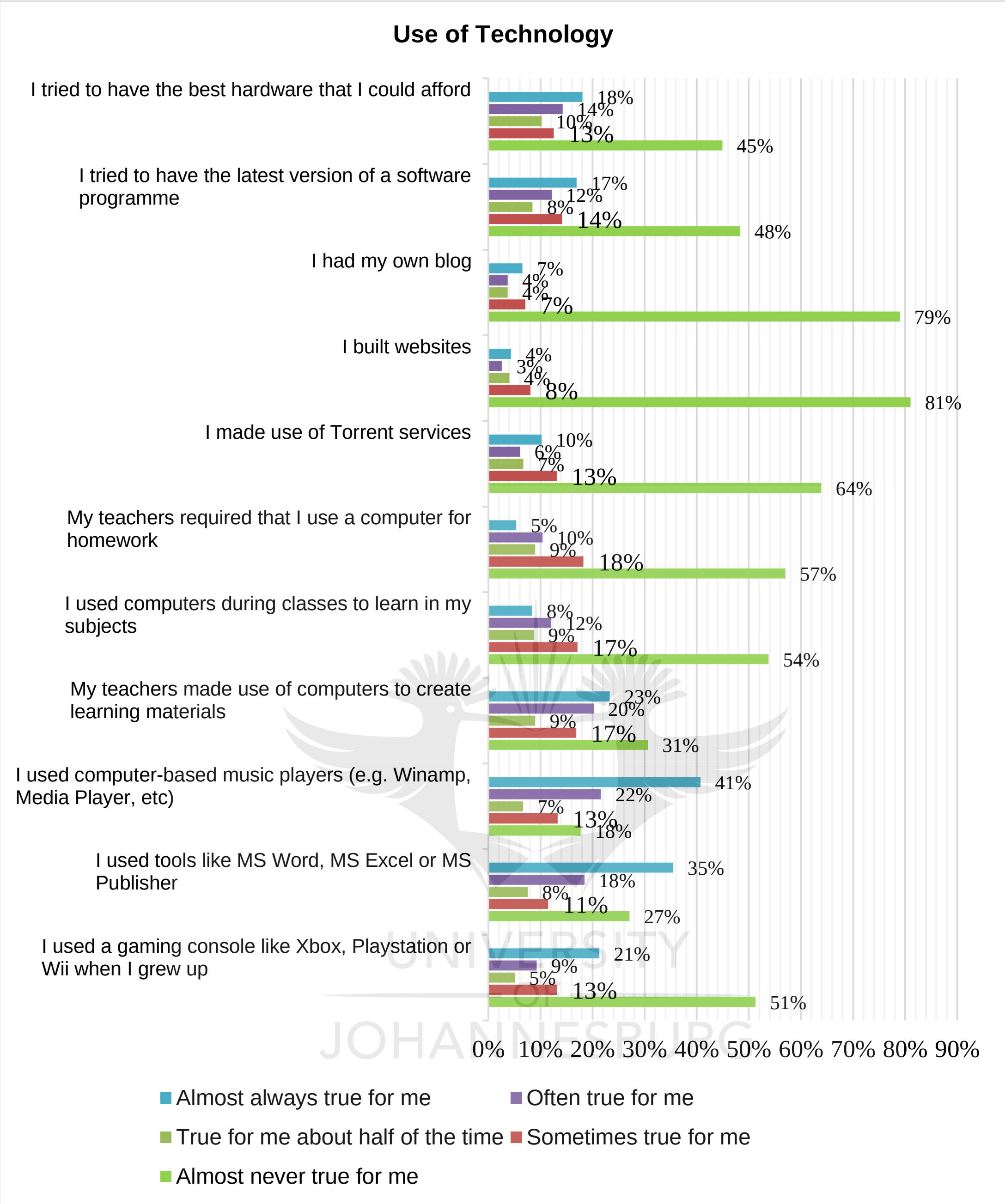



**Figure 4.14b:** Use of technology (cont.)

Figure 14a and 14b show that 53% of students did not make use of cloud based services, 63% did not use services like skype, 79% did not have a blog, 81% did not build their own websites, 64% did not use torrents, 57% of teachers did not require students to use a computer to do their homework, 54% of students did not use a computer during classes for learning purposes and 51% did not use a gaming console while growing up.

Interestingly, 49% of students reported that they did not use the Internet in the home in which they grew up. On the positive side, most students used a web-based email account (55%), used search engines to search for information (61%), used Instant Messaging (55%), used computer based music players (63%), and used MS Word or MS Excel (53%).

In order to statistically determine a student's use of technology the exploratory factor analysis was used to identify different items in Chapter 3 (see 3.10.1.5). The computer use factors identified were: Factor 1 = basic use, Factor 2 = medium use, Factor 3 = school use. The relationships and patterns within each item was then correlated with the dependent variable DS1 mark.

**Table 4.31:** Correlation of use of technology and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Factor 1 (use of technology) basic use** | Pearson Correlation | .188 |
| | Sig. (2-tailed) | .000 |
| | N | 366 |
| **Factor 2 (use of technology) medium use** | Pearson Correlation | .076 |
| | Sig. (2-tailed) | .148 |
| | N | 364 |
| **Factor 3 (use of technology) school use** | Pearson Correlation | .073 |
| | Sig. (2-tailed) | .167 |
| | N | 360 |



A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 1: basic use of technology and performance in DS1 variable. Basic use of technology includes using search engines for information, using tools like MS Word and MS Excel, using email, messaging and the Internet. There was a small, positive correlation between the two variables, r = .188, n = 366, p = .000. Overall, there was a small, positive correlation between a student's basic use of technology and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 2: medium use of technology and performance in DS1 variable. Medium use of technology includes using the Internet to make phone calls, banking, Torrent services, playing games, making use of cloud-based services. There was no correlation between the two variables, r = .076, n = 364, p = .148. The results show that for this group there is an insignificant correlation between a student's medium use of technology and performance in DS1.

A Pearson product-moment correlation coefficient was computed to assess the relationship between Factor 3: technology used at school and performance in DS1 variable. There was no correlation between the two variables, r = .073, n = 360, p = .167. The results show that for this group there is an insignificant correlation between a student's use of technology at school and performance in DS1.

### 4.2.7 Previous programming experience

Studies have indicated that students with little or no programming experience often struggle in computer programming courses (Holden & Weeden, 2003; Hagan & Markham, 2000; Zhang *et al*, 2013; Kumwenda, Rauchas & Sanders 2006). Students in this study were asked how much programming experience they had before enrolling for the National Diploma: Business Information Technology at the JCU and Information Technology at the PCU.

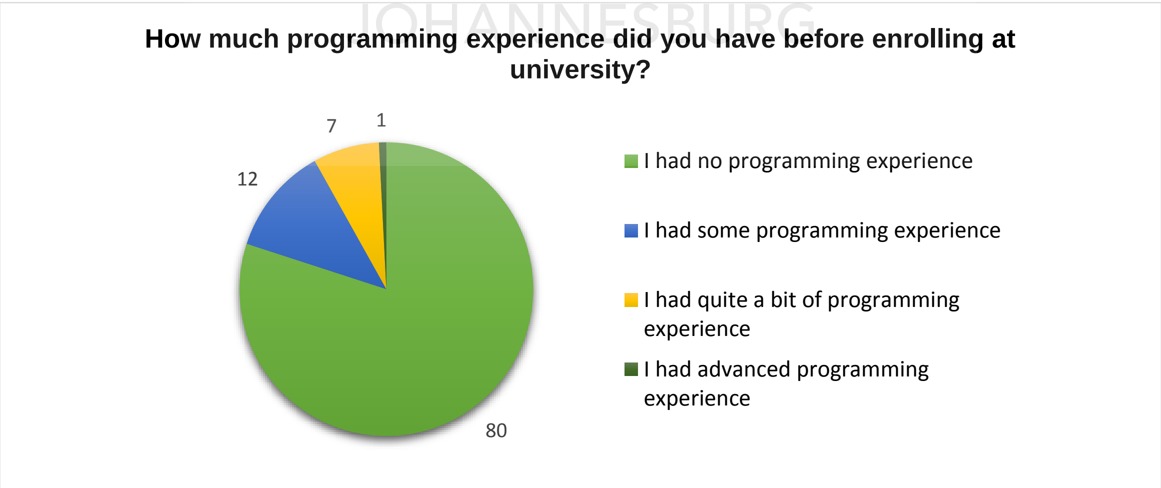



**Figure 4.15:** Students programming experience

Figure 4.15 shows that 80% of the students had no previous computer programming experience, 12% had some programming experience, 7% had quite a bit of programming experience and 1% had advanced programming experience.

**Table 4.32:** Correlation of programming experience and DS1 mark

| Correlations | | |
|---|---|---|
| | | **DS1 Mark** |
| **Q22 How much programming experience did you have before enrolling at university?** | Pearson Correlation | .186 |
| | Sig. (2-tailed) | .000 |
| | N | 370 |

A Pearson product-moment correlation coefficient was computed to assess the relationship between how much programming experience a student had before enrolling at university and performance in DS1 variable. There was a small, positive correlation between the two variables, r = .186, n = 370, p = .000. Overall, there was a small, positive correlation between a student's previous programming experience and performance in DS1.

## 4.3 DISCUSSION

This study investigated pre-entry attributes influencing students' performance in programming modules. The results revealed some noteworthy findings. There is a correlation between a student's logical reasoning (r = .199, p = .000), numerical reasoning (r = .257, p = .000) and verbal logic (r = .143, p = .008) and performance in computer programming modules. This supports findings of earlier studies done by Reed, Miller and Braught, (2000); Kimmel, Kimmel and Deek, (2003); Muller and Haberman, (2009) that problem solving ability is a major predictor of performance in programming courses. The correlation between students' non-verbal reasoning and performance in computer programming modules was, however, not significant. This could be because the ability to use pictures in thinking is to a large degree a matter of practice, not aptitude (Education.com, 2009).

Very little research could be found on the relationship between a student's socio-economic status and computer programming ability. The researcher considered a students': residential area, dwelling, level of education and employment status of the mother or female caregiver, level of education and employment status of the father or male caregiver. It could be concluded that, for this sample, there was no significant correlation between the socio-economic factors mentioned and students' performance in programming modules.

With regard to students' educational background, the literature review highlighted a lack of facilities, poor educational resources, overcrowded classrooms and a lack of qualified teachers as being contributing factors of a learner's poor performance. Encouragement in the area of critical thinking at school and critical thinking at home, teaching received at school, students learning and hours spent studying were addressed – however, there was no significant correlation between a student's educational background and performance in programming modules.

Another main pre-entry attribute is mathematical ability. The analysis of the results suggests that there is no correlation between a student's Grade 12 mathematics performance and performance in computer programming modules ($r = -.126$, $p = .079$) and National Senior Certificate mathematics performance and performance in computer programming modules ($r = .139$, $p = .192$). This is in contrast to Byrne and Lyons, (2001), Wilson and Shrock (2001), Gomes and Mendes (2008), and Bergin and Reilly (2005) who claimed that performance in mathematics can predict programming performance. There is a global belief that the concepts which a student has to comprehend in order to master mathematics problems are similar to those for computer programming (Byrne & Lyons, 2001). Mathematics aptitude is thus often a pre-requisite for acceptance into computer programming courses (Chumra, 1998). The researcher believes that a student's mathematics ability may correlate with a student's performance in computer programming modules, however, in the context of this study, students Grade 12 mathematics marks do not seem to correlate with their mathematics ability. Interestingly there is a correlation between a student's Grade 12 mathematics mark and numerical reasoning test mark ($r= .256$, $p= .000$), Grade 12 mathematics mark and logical reasoning test mark (r= .109, p= 0.49) and Grade 12 mathematical literacy mark and performance in computer programming modules.

Fifty eight point seven percent of students disagreed that their English ability prevented them from performing well academically even though only 9% of student's first language was reported as being English. There is no significant evidence to show a relationship between a student's Grade 12 English mark and their DS1 mark. The researcher believes that a students Grade 12 English mark may not be a true reflection of their English ability. The study did find however that a student's Grade 12 English mark correlates with their numerical reasoning test mark (r= .159, p= .004) and their verbal logical test mark (r= .125, p= .026).

Forty two percent of students either used a computer for the first time at University (26%) or had 1 to 2 years computer experience (16%) before embarking on their studies. 47% of students reported that they did not have access to a computer while growing up. The relationship between a students' computer experience and their DS1 mark was found to be significant (r = .155, p = .003) as was the relationship between a students' computer access and their DS1 mark (r = .149, p = .004). The relationship between a students' basic use of technology and their DS1 mark was also found to be significant (r = .188, p = .000). A study done by Allan and Kolesar (1997) revealed that any kind of computer experience, no matter how basic, is helpful in learning to program.

Eighty percent of the students had no previous computer programming experience. The relationship between a student's previous knowledge of programming and their DS1 mark was significant (r = .186, p = .000) which is in agreement with (Holden & Weeden, 2003; Hagan & Markham, 2000; Zhang *et al*, 2013; Kumwenda, Rauchas & Sanders 2006).

Table 4.33 indicates the summary of results.

**Table 4.33:** Summary of results

| Null Hypotheses | Accepted/Rejected |
|---|---|
| H01: There is no relationship between a novice South African programming student's problem solving abilities and their performance in computer programming modules. | **Rejected** |
| H02: There is no relationship between a novice South African programming student's socio-economic status and their performance in computer programming modules. | **Accepted** |
| H03: There is no relationship between a novice South African programming student's educational background and their performance in computer programming modules. | **Accepted** |
| H04: There is no relationship between a novice South African programming student's performance in school mathematics and their performance in computer programming modules. | **Accepted** |
| H05: There is no relationship between a novice South African programming student's performance in English at school level and their performance in computer programming modules. | **Accepted** |
| H06: There is no relationship between a novice South African programming student's digital literacy and their performance in computer programming modules. | **Rejected** |
| H07: There is no relationship between a South African programming student's previous programming experience and their performance in computer programming modules. | **Rejected** |

In the next chapter the conclusions, recommendations and suggestions for future work will be discussed.

# CHAPTER 5

# CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

## 5.1 OVERVIEW

This study attempted to isolate the pre-entry attributes that could influence the performance of Development Software 1 students. The pre-entry attributes included students' problem solving ability, socio-economic status, educational background, performance in school mathematics, English language proficiency, digital literacy and previous programming experience. The following research question was posed: ***"To what extent do selected pre-entry attributes influence South African students' performance in computer programming modules?"***

The objectives of the study were to determine if there is a relationship between:

- Novice South African programming students' problem solving abilities and their performance in programming modules.
- Novice South African programming students' socio-economic status and their performance in programming modules.
- Novice South African programming students' educational background and their performance in programming modules.
- Novice South African programming students' performance in school mathematics and their performance in programming modules.
- Novice South African programming students' performance in English and their performance in programming modules.
- Novice South African programming students' digital literacy and their performance in programming modules.
- South African programming students' previous programming experience and their performance in programming modules.

The sample consisted of 186 first year students enrolled for the National Diploma Business Information Technology (NDBIT) at the JCU and 193 first year students enrolled for the National Diploma Information Technology (NDIT) at the PCU.

## 5.2 SUMMARY

In summary, the analysis of the pre-entry attributes thought to influence a first year students' performance in computer programming modules lead to the following findings:

### 5.2.1 Hypothesis 1: There is no relationship between a novice South African programming student's problem solving abilities and their performance in computer programming modules

**Rejected**

In order to develop computer programming skills: critical thought, problem solving, attention to detail, accuracy and abstract thinking are required. The University of Kent's Careers and Employability Service Department assesses student's computer programming aptitude with tests measuring competencies such as numerical reasoning, logical reasoning, verbal reasoning and non-verbal reasoning which are required in computer programming jobs. These tests were adapted for this study. The students' problem solving ability is a significant factor in performance in programming modules, as students who did well in the computer programming aptitude tests performed better in DS1. Therefore, Hypothesis 1: There is no relationship between a novice South African programming student's problem solving abilities and their performance in computer programming modules is rejected and the alternate Hypothesis: There is a relationship between a novice South African programming student's problem solving abilities and their performance in computer programming modules is accepted.

The findings suggest that the teaching of problem-solving skills may provide opportunities to enhance students' programming performance and thinking processes. A similar finding was reported by Muller and Haberman (2009), in a study that identified Computer Science 1 (CS1) students as having experienced difficulties with: decomposing problems; developing sufficient solutions; and using previously seen solutions (even for elementary problems). To this end they introduced the course *Development of Algorithmic Problem-Solving Skills* (DAPSS) to be taken in parallel to studying CS1.

The main focus of DAPSS was to set aside the details of the programming language and concentrate on reflective processes, awareness to problem-solving behaviour and development of cognitive skills. Results showed that the DAPSS course had a positive effect on students' problem-solving skills which in turn improved their programming skills (Muller & Haberman, 2009).

### 5.2.2 Hypothesis 2: There is no relationship between a novice South African programming student's socio-economic status and their performance in computer programming modules

**Accepted**

The relationship between a student's socio-economic status and academic performance is well documented and intimates that students from an advantaged background will perform better academically (Howie, Scherman & Venter, 2008; Collier & Morgan, 2008; Kuh *et al*, 2007; Wells, 2008; Fleisch, 2007; REAP, 2008). It is evident that socio-economic factors play a role in students' performance, however in this context, a student's socio-economic status which was determined by: residential area; type of dwelling; mother, father or caregivers level of education; and mother, father or caregivers employment status, could not be correlated with performance in programming modules at the university level. Therefore, Hypothesis 2: There is no relationship between a novice South African programming student's socio-economic status and their performance in computer programming modules is accepted.

This result is surprising as Bourdieu (1986) suggests that the most powerful form of capital is economic capital. He adds that students at higher education institutions who have economic capital are at an advantage and are more likely to succeed academically. However, according to the Programme for International Student Assessment (PISA), the relationship between student performance and economic, social and cultural status is not deterministic of a student's academic performance (OECD, 2010), as many disadvantaged students, achieve well above what is predicted as do a proportion of students from privileged home backgrounds, perform below what is predicted. For any group of students there is a range in performance.

This affirms the findings of Pedrosa, Dachs, Maia, Andrade and Carvalho (2006) who found that students from a poor socio-economic status, have a higher relative performance than their peers. This can be considered as a phenomenon which the authors named "educational resilience". Yorke and Longden (2004), Cleyle and Philpott (2012), and Toni and Olivier (2004) concede that students can become committed to making a positive change in their lives and commit to their university studies by using their challenging socio-economic circumstances as an incentive.



### 5.2.3 Hypothesis 3: There is no relationship between a novice South African programming student's educational background and their performance in computer programming modules

**Accepted**

The quality of the South African education system can be summarised by statistics indicating that out of 100 learners who start school, 50 will reach Grade 12, 40 will pass, and only 12 will qualify to study at a university (Spaull, 2013). A student's educational background which was determined by students being encouraged to think critically at home and at school, the type of teaching they received in the classroom, their ability to self-regulate their learning, and hours spent studying (time-on-task), in this context, could not be correlated with performance in programming modules at the university level. Therefore, Hypothesis 3: There is no relationship between a novice South African programming student's educational background and their performance in computer programming modules is accepted.

Although this result is surprising, the research of Lee and McIntire (2001) agrees that there is no relationship between a student's educational background and academic performance. In their research, they investigated: rural schools; urban schools; school environments; limited instructional resources; and course offerings and correlated these with academic performance. They too found that there was no correlation between students' educational background and academic performance.

### 5.2.4 Hypothesis 4: There is no relationship between a novice South African programming student's performance in school mathematics and their performance in computer programming modules

**Accepted**

Grade 12 mathematics marks, in this context, could not be correlated with performance in programming modules at the university level. These results contradict those of Byrne and Lyons, (2001), Wilson and Shrock (2001), Gomes and Mendes (2008), and Bergin and Reilly (2005) who claimed that performance in mathematics can predict programming performance. This finding questions the notion of using school level exit marks as a criterion for admittance to university programmes in South Africa. The researcher's position is that the students Grade 12 mathematics mark, that was used to express mathematical ability, does not correlate with performance in the programming modules. The validity of the mark as being reflective of mathematical ability is questioned. Therefore, Hypothesis 4: There is no relationship between a novice South African programming student's performance in school mathematics and their performance in computer programming modules is accepted.

Govender found the same results in a study that revealed problem solving in programming is not strongly correlated to students' mathematics mark, possibly "*because Mathematics often is not taught as problem solving and typical tests do* *not test problem solving*" (2007: 39). Interestingly this study found a small significant correlation between a student's Grade 12 mathematical literacy mark and performance in computer programming modules. According to Houston, Tenza, Hough, Singh & Booyse (2015: 22), a study of the outcomes of the subject mathematical literacy shows that "*the largest proportion of skills required to perform well in this subject are of a high cognitive level*". The outcomes of mathematical literacy are to analyse, comprehend, interpret, conclude, make decisions, identify misleading information, read, write, communicate, use terminology correctly, draw graphs, solve problems involving calculation, and solve spatial problems (Houston, Tenza, Hough, Singh & Booyse, 2015: 22). Therefore, mathematical literacy may be a better 'fit' for computer programming than the subject mathematics.

### 5.2.5 Hypothesis 5: There is no relationship between a novice South African programming student's performance in school English and their performance in computer programming modules

**Accepted**

According to Bourdieu (1992), language is an embodied cultural capital that originates in the family. Students who are 2nd or 3rd language English speaking are thought to be at a disadvantage at HEIs where the language of instruction is English. Bourdieu explains that linguistic capital is central to educational success as it is closely linked to other forms of capital.

This finding is therefore surprising, as the majority of the students studying the NDBIT and NDIT were black (88%), and as a result spoke an African language as a first language. These students' did not receive tuition in their first language but rather in their second or even third language, as the language of instruction at school and university is English. Students Grade 12 English marks, in this context, could not be correlated with performance in programming modules at the university level. Therefore, Hypothesis 5: There is no relationship between a novice South African programming student's performance in English and their performance in computer programming modules is accepted.

This is in contrast to Maharaj and Gokal (2006); Seymour and Fourie (2010); Pillay and Jugoo (2005); Rauchas *et al* (2006) who claimed that performance in English can predict programming performance. However, the study conducted by Byrne *et al.* revealed that a students' programming performance is not affected by the fact that a student's mother tongue is different from the language of instruction (2001).

The researcher's position is that the students Grade 12 English mark, that was used to express English ability, does not correlate with performance in the programming modules. This does not mean that students' English ability cannot predict programming performance, but rather that the students Grade 12 English marks does not correlate with performance in the programming modules.

### 5.2.6 Hypothesis 6: There is no relationship between a novice South African programming student's digital literacy and their performance in computer programming modules

**Rejected**

Tertiary institutions today comprise a diverse student presence with a wide variety of digital literacy capabilities. In this study, the level of student's access to and use of technology entering the NDBIT and NDIT at the JCU and PCU is a significant factor in performance in programming modules, as students who had access to and used technology before embarking on their studies performed better in DS1. (See Barlow-Jones, van der Westhuizen & Coetzee, 2014 – Appendix K). Therefore, Hypothesis 6: There is no relationship between a novice South African programming student's digital literacy and their performance in computer programming modules is rejected and the alternate Hypothesis: There is a relationship between a novice South African programming student's digital literacy and their performance in computer programming modules is accepted. Very little literature could be found worldwide on the relationship between digital literacy and computer programming performance which suggests that this is a relatively new pre-entry attribute to be investigated.

### 5.2.7 Hypothesis 7: There is no relationship between a South African programming student's previous programming experience and their performance in computer programming modules

**Rejected**

Previous computer programming experience at school level has been discussed in the literature as having a positive influence in novice programmers' success (Kumwenda *et al*, 2006; Rountree *et al*, 2004.; Wiedenbeck, 2005; Pedroni, Oriol & Meyer, 2009; Holden & Weeden, 2003; Sheard et al, 2008; Hagan & Markham, 2000; Blewett & Achmad, 2005). Previous programming experience, in this context, significantly correlated with performance in programming modules at the university level. Therefore, Hypothesis 7: There is no relationship between a South African programming student's previous programming experience and their performance in computer programming modules is rejected and the alternate Hypothesis: There is a relationship between a South African student's previous programming experience and their performance in computer programming modules is accepted. Therefore it would deem that students with previous programming experience would be at an advantage in programming modules. However, all the studies above reported that, the advantage the students have over their novice programming peers, would be lost once the basic programming concepts had been learnt.

## 5.3 CONCLUSIONS

The majority of the pre-entry attributes could not be related to performance in programming modules, which is surprising considering that the literature, barring the variable digital literacy, supported each variable to have a relationship with computer programming. The fact that school performance in English and Mathematics could not be correlated with performance in the DS1 module raises questions about the validity of those Grade 12 marks as being representative of ability in English and Mathematics. It could very well be that school performance in those subjects are not an accurate representation of ability in the subjects. This has severe implications for the admission requirements to programming courses.

The admission requirements for the two HEIs where this study was conducted are as follows:

**Table 5.1:** JCU and PCU admission requirements for the NDBIT and NDIT

| **Johannesburg City University**<br>**NDBIT admission requirements** | **Pretoria City University**<br>**NDIT admission requirements** |
|---|---|
| Grade 12 mathematics mark of 40% and above or a mathematical literacy mark of 70% and above. | Grade 12 mathematics mark of 50% and above. |
| Grade 12 English mark of 50% and above. | Grade 12 English mark of 40% and above. |

However, this study showed that Grade 12 Mathematics, and English performance are not correlated with a student's performance in programming modules. The implication of this is that the school results in these two subjects may not be suitable criteria for admission to programming courses.

## 5.4 LIMITATIONS TO THE STUDY

The following limitations of the research are identified:

1. The questionnaire was lengthy, and the variables were informed by many items. It is not unreasonable to assume that the length of the questionnaire had an adverse effect on the quality of the responses due to respondent fatigue.

2. The selection of the variables that represented pre-entry attributes may not be representative of all possible pre-entry attributes that influence student performance in programming courses. For example, personal attributes like self-efficacy, metacognitive awareness, or others were not measured.

3. The mediating influence of variables post-enrolment on performance in the programming courses were not accounted for. The extent to which students

may have participated in learning support programmes, their time-on-task during the courses, their engagement with tutors, and the pedagogical design of the courses are but a few of possible post-enrolment variables that influenced their performance.

4. The study relied on quantitative data only. Engaging students in focus group interviews may have provided for a richer data set for an enhanced and more complete understanding of the influence of the variables on performance.

5. Much of the data was self-reported. Therefore, there may be misalignment in the conceptual understanding of students of items related to critical thinking, teacher pedagogy, and so forth, and the actual theoretical constructs that underpin those items.

6. The sample was comprised of students who enrolled for programming courses at the diploma level. Students who enrolled for degree-level courses were not sampled.

## 5.5 RECOMMENDATIONS FOR PRACTICE



Considering the finding of the study, and the limitations of the study that were identified, the following recommendations for practice are made:

1. That HEIs reconsider the use of Grade 12 mathematics and English marks as admission requirements to programming courses. A better measure of a student's mathematical ability and English ability could be the National Benchmark Tests (NBTs) which were introduced into South African universities in 2009 because of the national concern of the quality of students entering universities.

2. NBTs should be made compulsory for first year students studying computer programming courses.

3. Grade 12 mathematics mark should be replaced by the NBT mathematics test score as an admission criterion into programming courses.

4. Grade 12 English marks should be replaced by the NBT academic literacy test score as an admission criterion into programming courses.

5. Introducing problem solving support modules in conjunction with a computer programming module, similar to that of Muller and Haberman (2009) may be beneficial.

## 5.6 RECOMMENDATIONS FOR FUTURE RESEARCH

The following further research is proposed:

1. When the requirement for first year IT students to complete NBT assessments is made compulsory, it would be useful to examine the relationship between the NBT results for mathematics and academic literacy and performance in computer programming modules.



2. Future research should incorporate changes to the Student Profile Questionnaire: namely, instead of self-reporting, only standardised questions should be integrated; other constructs like self-efficacy, metacognitive awareness etcetera should also be included; the length of the questionnaire should be condensed.

3. Since the respondents of this study were enrolled for a diploma course, the same study could be extended to include degree students.

4. Future research could be extended to post-enrolment variables that may contribute to the performance of students in programming modules for

example: programming support received; time-on-task; and pedagogy incorporated at the institution.

## 5.7 CLOSING REMARKS

This study examined the relationship between seven pre-entry attributes and performance in computer programming modules at two universities in South Africa. The dataset comprised of four programming aptitude tests, a student profile questionnaire and Development Software 1 examination results of 379 students studying the NDBIT and NDIT at the JCU and PCU. Correlations were made between the seven independent variables and the dependent variable (DS1 examination marks). The data analysed indicated that there is a correlation between the variables problem solving, digital literacy and previous programming experience and performance in programming modules. There was no correlation found between the variables socio-economic status, educational background, Grade 12 mathematics mark and English mark and performance in programming modules. In conclusion the mark achieved for school mathematics and English cannot be considered as a valid admission criterion for programming courses in the South African context and an alternate requirement such as the NBT's should be implemented.

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# APPENDIX A

UNIVERSITY OF JOHANNESBURG

3 February 2013

Dear Student

This questionnaire forms part of a research project on **first year students** who are enrolled in courses in Information Technology at the University of Johannesburg and at the Tshwane University of Technology. The research is done as part of PhD studies under the supervision of Prof D vd Westhuizen from the Department of Science and Technology Education from the University of Johannesburg. We are particularly interested in isolating those factors that may influence your success in the modules that you enrolled for. The information that you provide will be helpful as it will assist us in determining those factors which may influence your performance in the modules that you are enrolled for. This in turn will assist in re-designing the modules to address your needs more accurately, and to develop supporting learning activities that will assist you in becoming successful in your studies.

Your participation in this research is voluntary, and you may elect not to complete the questionnaire at all. You may choose to do so without fear of any harm or penalty to you whatsoever. No attempt is made to collect information about you that may possibly harm you in any way should you reveal such information. Individual information will never be known to anyone except the research team, and no information in the research report will be released that would identify you as an individual. Your student number is requested as it will assist us in obtaining information about your performance in all your modules, which is essential for the research. No student numbers will be published in the research report. You will remain totally anonymous. The findings of the research will be included in the PhD reports and possibly journal publications that may emanate from the research. Should you wish, you may request a copy of the PhD report when it is completed, from the undersigned PhD students.

The collected written data will be kept in storage for three years, in accordance with the regulations of the University of Johannesburg, after which it will be destroyed. It will also be captured electronically in a statistical analysis software tool. Your name will not be captured electronically. The electronic data will be kept for posterity for research purposes only. You may at any stage of the research request to have your information removed from the dataset.

We kindly request that you complete the questionnaire as honestly and accurately as possible. It should not take you more than 30 minutes.

Thank you in anticipation for your time and participation.

I, ______________________________________________ ________________

Name and Surname Student Number

am completing this questionnaire voluntarily in order to participate in the research being conducted by Mrs G Barlow-Jones and Mrs J Chetty. I have taken note of my rights as explained above and I am aware that I may withdraw my participation at any time

## APPENDIX B

## STUDENT PROFILE QUESTIONNAIRE

**Instructions**:

1. Select only **one answer** unless otherwise specified for each question by making an **X** in the appropriate box.
2. Where you are required to fill in the answer, use only the space provided.
3. Please be as accurate and honest as you can be. **There are no RIGHT or WRONG answers.**

1. What is your institution? UJ ☐ TUT ☐

2. Please enter your Student Number here ☐☐☐☐☐☐☐☐☐

3. How would you describe the immediate environment in which you grew up?

| | |
|---|---|
| 1. Informal settlement | 1 |
| 2. Rural village/farm | 2 |
| 3. Township | 3 |
| 4. A town | 4 |
| 5. Suburb in a city | 5 |
| 6. Inner city | 6 |
| 7. Other: (Please specify) | 7 |

4. Which of the following best describes the house in which you grew up?

| | |
|---|---|
| 1. Informal dwelling in an informal squatter settlement or on a farm | 1 |
| 2. Room/flat on a property or servant's quarters/granny flat | 2 |
| 3. Traditional dwelling/hut/structure made of traditional materials e.g. mud | 3 |
| 4. Flat/apartment in a block of flats/cluster house in a complex/townhouse | 4 |
| 5. House or brick/concrete structure on a separate stand or yard or on a farm | 5 |
| 6. Other: (Please specify) | 6 |

5. Please indicate Yes or No to <u>each</u> of the following statements. In cases where the circumstances changed while you were growing up, select the answer that is applicable for the most of the time while you were growing up.

| **Statement: While I was growing up, we ….** | **No** | **Yes** |
|---|---|---|
| 1. Had electricity in our home | 1 | 2 |
| 2. Subscribed to DSTV/Top TV | 1 | 2 |
| 3. Watched the SABC channels and/or E-TV | 1 | 2 |
| 4. Had a landline telephone service | 1 | 2 |
| 5. Used cell phones | 1 | 2 |
| 6. Had a radio/sound system/multimedia system | 1 | 2 |
| 7. Had a VCR or DVD or Blue Ray system | 1 | 2 |

6. What is the highest qualification that each of your parents or caregivers holds?

| | Mother/Female | Father/Male |
|---|---|---|
| 1. Never attended school | 1 | 2 |
| 2. Primary school or high school, but not Std10/Grade 12 | 1 | 2 |
| 3. Grade 12/Senior Certificate | 1 | 2 |
| 4. Post School Certificate/Diploma | 1 | 2 |
| 5. Degree | 1 | 2 |
| 6. Post Graduate Degree | 1 | 2 |
| 7. I don't know | 1 | 2 |
| 8. Not applicable | 1 | 2 |

7. If your parent(s) or care giver(s) are currently employed, what is the nature of their employment?

| | Mother/Female | Father/Male |
|---|---|---|
| 1. Currently unemployed | 1 | 2 |
| 2. Retired | 1 | 2 |
| 3. Informally employed e.g. piece job | 1 | 2 |
| 4. Unskilled labour | 1 | 2 |
| 5. Skilled labour e.g. mechanic | 1 | 2 |
| 6. Retail/Services/Government/Local Government | 1 | 2 |
| 7. Professional e.g. teacher/lawyer/accountant | 1 | 2 |
| 8. Entrepreneur/business owner | 1 | 2 |
| 9. Not applicable | 1 | 2 |
| 10. Unsure | 1 | 2 |
| 11. Other: (Please specify) | 1 | 2 |



8. The left-most column contains statements that relate to your high school years. For each statement, indicate the extent to which you agree with the statement as it applies to most of your **SCHOOLING** (COLUMN A) and the circumstances in the **HOME** in which you grew up (COLUMN B).

**SD = Strongly Disagree**
**D = Disagree**
**A = Agree**
**SA = Strongly Agree**
**NA = I cannot respond to the statement/I don't understand the statement**

| To what extent do you agree that the following applied to you | A: At my school | | | | | B: In my home | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 1. My critical thinking skills were deliberately developed | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 2. It was expected that I had to consider the consequences of my actions before I acted | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 3. I was encouraged to look for patterns in things that I observed | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 4. I was encouraged to use mind maps to show how things relate to each other | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 5. I was encouraged to use tables to organise information | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 6. I was encouraged to consider the advantages and disadvantages before making choices | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 7. I was encouraged to talk to others when I had to solve problems | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 8. I was encouraged to find multiple solutions to problems | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 9. I was encouraged to use Brainstorming techniques when I had to solve problems | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 10. I was encouraged to break a problem into different parts in order to solve it | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 11. I was encouraged to think independently of others, to have my own mind about matters | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 12. I was encouraged to attend extra lessons to improve my performance in subjects | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 13. I was encouraged to regularly study after hours or study extra hours to improve my marks | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 14. I was encouraged to study hard so that I could achieve university entrance | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 15. I was encouraged to do planning before I attempted a task | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 16. I was encouraged to check my work for mistakes before I submitted it | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 17. I was encouraged to keep on trying until a task was completed despite difficulties I faced | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 18. I was encouraged to keep to the deadlines that were set for tasks | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 19. I was encouraged to be conscientious about my school work | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 20. I was encouraged to be creative when I had to complete tasks | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 21. I was encouraged to read a lot to improve my knowledge | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 22. I was encouraged to play games that required problem-solving skills | SD | D | A | SA | NA | SD | D | A | SA | NA |

| To what extent do you agree that the following applied to you | A: At my school | | | | | B: In my home | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 1. My critical thinking skills were deliberately developed | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 2. It was expected that I had to consider the consequences of my actions before I acted | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 3. I was encouraged to look for patterns in things that I observed | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 4. I was encouraged to use mind maps to show how things relate to each other | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 5. I was encouraged to use tables to organise information | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 6. I was encouraged to consider the advantages and disadvantages before making choices | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 7. I was encouraged to talk to others when I had to solve problems | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 8. I was encouraged to find multiple solutions to problems | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 9. I was encouraged to use Brainstorming techniques when I had to solve problems | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 10. I was encouraged to break a problem into different parts in order to solve it | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 23. I was encouraged to take notes in class that I could use to study from | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 24. I was encouraged to work or study in groups with my peers | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 25. I was encouraged to have an inquiring mind and to always ask questions | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 26. I was encouraged to question authority if I believed people in authority were wrong | SD | D | A | SA | NA | SD | D | A | SA | NA |
| 27. I was encouraged to ask others to help solve problems | SD | D | A | SA | NA | SD | D | A | SA | NA |



**PLEASE CHECK THAT YOU HAVE COMPLETED BOTH COLUMNS A AND B ABOVE BEFORE MOVING ON TO THE NEXT QUESTION.**

9. Thinking back to your last school year, on average, how many hours per day did you spend on homework and studying?

| | |
|---|---|
| 1. Less than 1 hour a day | 1 |
| 2. 1 hour a day | 2 |
| 3. 2 hours a day | 3 |
| 4. 3 hours a day | 4 |
| 5. 4 or more hours a day | 5 |

10. My English ability prevents me from performing well academically.

| Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

11. How many of your siblings attend/attended university?

| | | |
|---|---|---|
| 1. | None | 1 |
| 2. | One | 2 |
| 3. | Two | 3 |
| 4. | Three | 4 |
| 5. | Four | 5 |
| 6. | 5 or more | 6 |

12. To what extent are the statements below true for you? Select from the following options:

**AN = Almost never true for me**
**S = Sometimes true for me**
**HT = True for me about half of the time**
**O = Often true for me**
**AA = Almost always true for me**
**NA = I cannot respond to the statement/I don't understand the statement**

| Teaching at my school | AN | S | HT | O | AA | NA |
|---|---|---|---|---|---|---|
| 1. My teachers taught by reading from the text book | AN | S | HT | O | AA | NA |
| 2. My teachers encouraged us to learn from more than just the textbook | AN | S | HT | O | AA | NA |
| 3. My teachers taught by reading a transparency on an overhead projector | AN | S | HT | O | AA | NA |
| 4. In my school, each learners had his/her own textbooks | AN | S | HT | O | AA | NA |
| 5. My teachers used additional resources besides the textbook | AN | S | HT | O | AA | NA |
| 6. My teachers stuck closely to the syllabus | AN | S | HT | O | AA | NA |
| 7. My teachers encouraged debating during class times | AN | S | HT | O | AA | NA |
| 8. My teachers encouraged learners to know their work "off by heart" | AN | S | HT | O | AA | NA |
| 9. My teachers encouraged learners to have alternative opinions | AN | S | HT | O | AA | NA |
| 10. My teachers were experts in their subjects | AN | S | HT | O | AA | NA |
| 11. My teachers taught more than just the textbook | AN | S | HT | O | AA | NA |
| 12. My teachers expected their learners to be critical thinkers | AN | S | HT | O | AA | NA |
| 13. My teachers taught problem-solving techniques | AN | S | HT | O | AA | NA |
| 14. My teachers used interesting teaching methods (besides "telling") | AN | S | HT | O | AA | NA |
| 15. My teachers expected us to summarise the work in the textbook | AN | S | HT | O | AA | NA |
| 16. My teachers explained the real-world relevance of the work we did | AN | S | HT | O | AA | NA |
| 17. We were encouraged to do projects that were innovative | AN | S | HT | O | AA | NA |
| 18. My teachers made sure that we got the "big picture" | AN | S | HT | O | AA | NA |
| 19. My teachers challenged learners to extend themselves | AN | S | HT | O | AA | NA |
| 20. My teachers taught us how to think abstractly | AN | S | HT | O | AA | NA |
| 21. My teachers made a deliberate effort to develop higher-order thinking skills like analysis, comparisons, evaluation, etc | AN | S | HT | O | AA | NA |
| 22. My teachers required learners to reflect on their learning | AN | S | HT | O | AA | NA |
| 23. My teachers encouraged learners to find the errors in their work | AN | S | HT | O | AA | NA |

13. To what extent are the statements below true for you? You need to respond in terms of the following options:

**AN = Almost never true for me**
**S = Sometimes true for me**
**HT = True for me about half of the time**
**O = Often true for me**
**AA = Almost always true for me**
**NA = I cannot respond to the statement/I don't understand the statement**

| Statement | AN | S | HT | O | AA | NA |
|---|---|---|---|---|---|---|
| 1. I plan first before I begin with a task | AN | S | HT | O | AA | NA |
| 2. I keep checking that I'm on the right track while I'm busy with a task | AN | S | HT | O | AA | NA |
| 3. I work hard at a task even though I don't like a task | AN | S | HT | O | AA | NA |
| 4. I believe I will perform well in this course | AN | S | HT | O | AA | NA |
| 5. I carefully plan the necessary steps before I proceed with action | AN | S | HT | O | AA | NA |
| 6. I'm convinced that I will understand the most parts of this course | AN | S | HT | O | AA | NA |
| 7. I try to understand problems before I attempt to solve them | AN | S | HT | O | AA | NA |
| 8. I work as hard as possible on all tasks given to me | AN | S | HT | O | AA | NA |
| 9. I'm convinced that I will understand the basic parts of this course | AN | S | HT | O | AA | NA |
| 10. I try to understand the goal of a task before I attempt to complete it | AN | S | HT | O | AA | NA |
| 11. I know how much of a task I still have to complete while working at it | AN | S | HT | O | AA | NA |
| 12. I do extra work on tasks to improve my knowledge | AN | S | HT | O | AA | NA |
| 13. I set goals and determine what I need to do to accomplish those goals | AN | S | HT | O | AA | NA |
| 14. I am focussed on the task at hand and do not get distracted easily | AN | S | HT | O | AA | NA |
| 15. I check and correct my errors before I submit a task | AN | S | HT | O | AA | NA |
| 16. I work hard on a task even if it does not count | AN | S | HT | O | AA | NA |
| 17. I expect to do well in this course | AN | S | HT | O | AA | NA |
| 18. I make sure I understand what has to be done and how to do it before I start a task | AN | S | HT | O | AA | NA |
| 19. I check whether I am "on track" as I progress through a task | AN | S | HT | O | AA | NA |
| 20. A task is a useful way to check my knowledge of something | AN | S | HT | O | AA | NA |
| 21. I am certain I can master the skills being taught in this course | AN | S | HT | O | AA | NA |
| 22. I try to determine all the requirements of a task before I begin it | AN | S | HT | O | AA | NA |
| 23. I ask myself how well am I doing, as I progress through tasks | AN | S | HT | O | AA | NA |
| 24. I believe practice makes perfect | AN | S | HT | O | AA | NA |
| 25. Considering my skills and knowledge, I think I will do well in this course. | AN | S | HT | O | AA | NA |
| 26. I know which parts of the work I know well and which I do not know well | AN | S | HT | O | AA | NA |



14. How much time are you planning on studying every day (exclude classes, practical's and tutorials).

| | |
|---|---|
| 1. Less than 1 hour a day | 1 |
| 2. 1 hour a day | 2 |
| 3. 2 hours a day | 3 |
| 4. 3 hours a day | 4 |
| 5. 4 or more hours a day | 5 |

15. Was this programme your first choice of study?

| | |
|---|---|
| No | 1 |
| Yes | 2 |

16. Below is a list of reasons why you would want to do well in your modules. Using the scale provided, please rate the importance of each reason to you.

| I want to do well in my modules…….. | **Not applicable, I have no interest in doing well** | **Not at all important** | **Low importance** | **Moderately important** | **Very important** |
|---|---|---|---|---|---|
| 1. To prove to myself I can do it (for my own satisfaction) | 1 | 2 | 3 | 4 | 5 |
| 2. To make others, such as my family, proud of me | 1 | 2 | 3 | 4 | 5 |
| 3. To have an advantage when I apply for jobs | 1 | 2 | 3 | 4 | 5 |
| 4. To avoid getting into trouble if I fail or perform badly | 1 | 2 | 3 | 4 | 5 |
| 5. Other reasons I want to do well (please specify) | | | | | |

17. What, in your mind, will prevent you from performing well in the programming modules of your courses? Rank the options from GREATEST OBSTACLE (1) to SMALLEST OBSTACLE (5). E.G. If "My language ability" is your greatest obstacle, and "My existing computer skills" is your smallest obstacle, you will put a 1 in the Rank block opposite "My language ability" and a 5 in the Rank block opposite "My existing computer skills"

| | **Rank** |
|---|---|
| 1. Your existing computer skills | |
| 2. Your problem-solving skills | |
| 3. Your mathematical ability | |
| 4. Your language ability | |
| 5. Your ability to think abstractly | |

| |
|---|
| Do you have another obstacle? Write it down here. |

18. Below are the possible reasons that may have motivated you to enrol for this qualification. Please RANK them where 1 is the MOST IMPORTANT reason and 7 is the LEAST important reason. Rank ALL of the options.

| | Rank |
|---|---|
| 1. I am interested in computers and I want to learn more than I already know | |
| 2. I want to have a career in computers because I just love computers so much | |
| 3. There are many jobs in the computer field, so I'm virtually guaranteed a job | |
| 4. I don't really know why I chose this qualification. I could have been anything else | |
| 5. I like to solve problems, and computer programming is all about solving problems | |
| 6. Most jobs today require computer knowledge, this is a good way to learn computers | |
| 7. There is lots of money in computers. I want to get me some of that! | |

Do you have another reason? Write it down here.

19. Please indicate Yes or No to each of these statements. Which of the following do you own or use?

| I own/use …. | No | Yes |
|---|---|---|
| 1. A cell phone (no Internet access) | 1 | 2 |
| 2. A cell phone that is not a smart phone, it can access the Internet | 1 | 2 |
| 3. A smart phone (e.g. BlackBerry, iPhone, Galaxy) | 1 | 2 |
| 4. A Laptop or Desktop computer | 1 | 2 |
| 5. A tablet (e.g. a Playbook or iPad or Galaxy Tab) | 1 | 2 |
| 6. I own or use none of the above | 1 | 2 |

20. How much experience do you have with computers?

| | |
|---|---|
| 1. I used computers for the first time at university | 1 |
| 2. 1 to 2 years | 2 |
| 3. Since High School days | 3 |
| 4. Since Primary School days | 4 |
| 5. I used computers before I even started school | 5 |

21. Please indicate Yes or No to each of these statements. Which of the following do you have?

| I have …. | No | Yes |
|---|---|---|
| 1. A web-based email account (e.g. Gmail, Hotmail) | 1 | 2 |
| 2. A Facebook account | 1 | 2 |
| 3. A Twitter account | 1 | 2 |
| 4. A Mxit account | 1 | 2 |
| 5. Other Social Media: (Please Specify) | 1 | 2 |

22. How much programming experience did you have before enrolling at university?

| | |
|---|---|
| 1. I had no programming experience | 1 |
| 2. I had some programming experience | 2 |
| 3. I had quite a bit of programming experience | 3 |
| 4. I had advanced programming experience | 4 |

23. How many computers did you have access to in your home while growing up?

| | |
|---|---|
| 1. There were no computers in my home while I was growing up | 1 |
| 2. There was ONE computer in my home while I was growing up | 2 |
| 3. There were TWO computers in my home while I was growing up | 3 |
| 4. There were THREE computers in my home while I was growing up | 4 |
| 5. There was a computer for each member of my family in my home while I was growing up | 5 |

24. Select from the options below the extent to which each statement is applicable to you, as the statement applies to you **BEFORE** YOU ENROLLED AT UNIVERSITY (in other words, when you were in high school).

**AN = Almost never true for me**
**S = Sometimes true for me**
**HT = True for me about half of the time**
**O = Often true for me**
**AA = Almost always true for me**
**NA = I cannot respond to the statement/I don't understand the statement**

| **Use of Technology** | | **AN** | **S** | **HT** | **O** | **AA** | **NA** |
|---|---|---|---|---|---|---|---|
| 1. | I used a computer in the home where I grew up | AN | S | HT | O | AA | NA |
| 2. | I used the Internet in the home where I grew up | AN | S | HT | O | AA | NA |
| 3. | I used a computer in the computer centre at school | AN | S | HT | O | AA | NA |
| 4. | I used the Internet on a computer at school | AN | S | HT | O | AA | NA |
| 5. | I used Internet Messaging (IM) like Yahoo/Windows Messenger or Mxit | AN | S | HT | O | AA | NA |
| 6. | I used search engines to search for information | AN | S | HT | O | AA | NA |
| 7. | I used the web for playing games | AN | S | HT | O | AA | NA |
| 8. | I accessed educational websites to learn more about my subjects | AN | S | HT | O | AA | NA |
| 9. | I used the web for banking, online ticketing, and other similar services | AN | S | HT | O | AA | NA |
| 10. | I used a web-based email account to send or receive email | AN | S | HT | O | AA | NA |
| 11. | I used the web to make phone calls (e.g. Skype) | AN | S | HT | O | AA | NA |
| 12. | I made use of cloud-based services like Google Drive, or Drop Box | AN | S | HT | O | AA | NA |
| 13. | I used a gaming console like Xbox, Playstation or Wii when I grew up | AN | S | HT | O | AA | NA |
| 14. | I used tools like MS Word, MS Excel or MS Publisher | AN | S | HT | O | AA | NA |
| 15. | I used computer-based music players (e.g. Winamp, Media Player, etc) | AN | S | HT | O | AA | NA |
| 16. | My teachers made use of computers to create learning materials | AN | S | HT | O | AA | NA |
| 17. | I used computers during classes to learn in my subjects | AN | S | HT | O | AA | NA |

| Use of Technology | | AN | S | HT | O | AA | NA |
|---|---|---|---|---|---|---|---|
| 18. | My teachers required that I use a computer for homework | AN | S | HT | O | AA | NA |
| 19. | I made use of Torrent services | AN | S | HT | O | AA | NA |
| 20. | I built websites | AN | S | HT | O | AA | NA |
| 21. | I had my own blog | AN | S | HT | O | AA | NA |
| 22. | I tried to have the latest version of a software programme | AN | S | HT | O | AA | NA |
| 23. | I tried to have the best hardware that I could afford | AN | S | HT | O | AA | NA |
| 24. | How else did you use computers? Please specify | | | | | | |

25. Gender

| | |
|---|---|
| Male | 1 |
| Female | 2 |

26. Age

| |
|---|
| |

27. Ethnicity

| | |
|---|---|
| Black | 1 |
| White | 2 |
| Coloured | 3 |
| Indian | 4 |
| Asian | 5 |
| Other: Please specify | 6 |



28. Please indicate your first, second and third language in the table below:

| No. | First Language | | Second Language | | Third Language | |
|---|---|---|---|---|---|---|
| 1. | English | 1 | English | 1 | English | 1 |
| 2. | Afrikaans | 2 | Afrikaans | 2 | Afrikaans | 2 |
| 3. | IsiZulu | 3 | IsiZulu | 3 | IsiZulu | 3 |
| 4. | IsiXhosa | 4 | IsiXhosa | 4 | IsiXhosa | 4 |
| 5. | Sesotho | 5 | Sesotho | 5 | Sesotho | 5 |
| 6. | Tshivenda | 6 | Tshivenda | 6 | Tshivenda | 6 |
| 7. | SiSwati | 7 | SiSwati | 7 | SiSwati | 7 |
| 8. | Xitsonga | 8 | Xitsonga | 8 | Xitsonga | 8 |
| 9. | IsiNdebele | 9 | IsiNdebele | 9 | IsiNdebele | 9 |
| 10. | Setswana | 10 | Setswana | 10 | Setswana | 10 |
| 11. | Sepedi | 11 | Sepedi | 11 | Sepedi | 11 |
| 12. | Other: Specify | 12 | Other: Specify | 12 | Other: Specify | 12 |
| 13. | | | | | I don't speak a 3rd language | 13 |

29. Are you a South African Citizen?

| | |
|---|---|
| Yes | 1 |
| No | 2 |

30. If you answered no to the above question, please indicate which country you are from?

| |
|---|
| |

31. What is the name of the school that you matriculated from?

Name of School: ______________________________________________

Province: ______________________________________________

Private School ☐ Government School ☐

32. For each Grade 12 subject chosen, indicate with an X the final grade you received for that subject.

Example: If you got 53% for maths you would mark it off as follows:

| | | Grading Scale | | | | | |
|---|---|---|---|---|---|---|---|
| **No.** | **Subject** | **0%-39%** | **40% - 49%** | **50% - 59%** | **60% - 69%** | **70% - 79%** | **80% - 100%** |
| **1.** | **Mathematics** | 0 | 1 | X | 3 | 4 | 5 |
| 1. | 1st Language: Specify: | 0 | 1 | 2 | 3 | 4 | 5 |
| 2. | 2nd South Language Specify: | 0 | 1 | 2 | 3 | 4 | 5 |
| 3. | Mathematics | 0 | 1 | 2 | 3 | 4 | 5 |
| 4. | Math's Literacy | 0 | 1 | 2 | 3 | 4 | 5 |
| 5. | Computer Applications Technology (CAT) | 0 | 1 | 2 | 3 | 4 | 5 |
| 6. | Information Technology | 0 | 1 | 2 | 3 | 4 | 5 |
| 7. | Life Orientation | 0 | 1 | 2 | 3 | 4 | 5 |
| 8. | Geography | 0 | 1 | 2 | 3 | 4 | 5 |
| 9. | History | 0 | 1 | 2 | 3 | 4 | 5 |
| 10. | Life Sciences | 0 | 1 | 2 | 3 | 4 | 5 |
| 11. | Accounting | 0 | 1 | 2 | 3 | 4 | 5 |
| 12. | Other: Specify | 0 | 1 | 2 | 3 | 4 | 5 |
| 13. | Other: Specify | 0 | 1 | 2 | 3 | 4 | 5 |
| 14. | Other: Specify | 0 | 1 | 2 | 3 | 4 | 5 |

33. Indicate whether you are doing the Diploma Course or Foundation Course.

| | |
|---|---|
| Diploma | 1 |
| Foundation | 2 |

34. Indicate whether you are a first time student in first year or a repeater

| | |
|---|---|
| First time Student | 1 |
| Repeater | 2 |

**Thank you. This is the end of the questionnaire.**

## APPENDIX C

Name & Surname ________________________________________ Student No. ____________

# COMPUTER PROGRAMMING APTITUDE TEST

The computer programming aptitude tests consists of a **standard battery of tests** assessing competencies such as numerical reasoning, logical reasoning, non-verbal reasoning and verbal logic which are required in technical computing jobs.

---

## LOGICAL REASONING TEST

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This test involves letter sequences and tests your **ability to think logically and analytically**.

The test has **10 questions** and you will have **20 minutes** to do them**. Please use the SCRAP PAPER at the back of the test for working out answers.**

**Instruction:** Using the alphabet at the top of the question, look at the sequence given and work out which letter is the next member of the sequence.

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

**Example:** What is the missing letter in this series:

a a b b **?** c

**Answer = c**



---

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

1. What is the missing letter in this series:

   c c d **?** e f g g h

   ____________________________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

2. What is the missing letter in this series:

   f g e h d i c **?**

   ____________________________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

3. What is the missing letter in this series:

   b e h k n **?** t

   ______________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

4. What is the missing letter in this series:

   x **?** p l h

   ______________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

5. What is the missing letter in this series:

   j g d k **?** e l

   ______________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

6. What is the missing letter in this series:

   b g d i **?** k h

   ______________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**



7. What is the missing letter in this series:

   g **?** d i j d k l d

   ______________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

8. What is the missing letter in this series:

   g g k k o o **?**

   ______________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

9. What is the missing letter in this series:

v s p w t q **?**

______________________________________________

**A B C D E F G H I J K L M N O P Q R S T U V W X Y Z**

10. What is the missing letter in this series:

y d j w f l u h **?**

______________________________________________

## LOGICAL REASONING TEST

### Answers

| Question | Answer | How to work out the answer |
|---|---|---|
| 1 | e | ccd ... **E**ef ... ggh! |
| 2 | j | 2 interspersed sequences. First decreasing by one: fedc and second increasing by one: ghi **J** |
| 3 | q | Letters go up by three each time. 2nd letter of alphabet, 5th 8th etc. |
| 4 | t | Letters decrement by 4 each time |
| 5 | h | Letters are in triplets which decrement by 3, but starting letter of each triplet increments by one: 10,7,4 ... 11,**8**,5 |
| 6 | f | 2 seqences interspersed, both incrementing by 2 each time |
| 7 | h | Take out the d's and you get a simple alphabetical sequence! |
| 8 | s | Letters are in pairs which increment by 4 places in the alphabet each time. |
| 9 | x | Each whole triplet increments by one, whilst the letters in the triplet decrease by 3. |
| 10 | n | Each third letter increments by 2 |

## APPENDIX D

Name & Surname ________________________________________ Student No. ____________

# COMPUTER PROGRAMMING APTITUDE TEST

The computer programming aptitude tests consists of a **standard battery of tests** assessing competencies such as numerical reasoning, logical reasoning, non-verbal reasoning and verbal logic which are required in technical computing jobs.

---

## NON-VERBAL REASONING TEST

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The test has **10 questions** and you will have **20 minutes** to do them. **Please use the SCRAP PAPER at the back of the test for working out answers.**

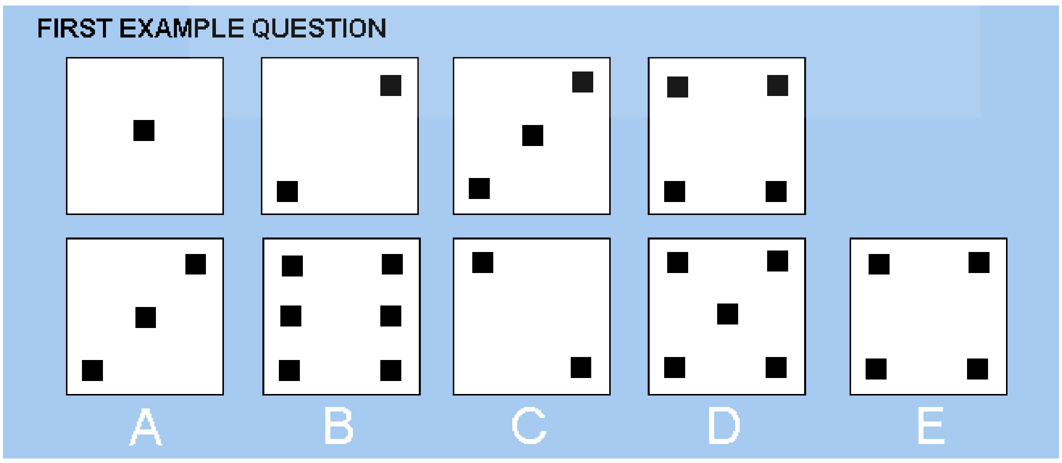
This test will test your non-verbal reasoning as the questions appear in diagrammatic and pictorial form.

Non-verbal reasoning involves the **ability to understand and analyse visual information and solve problems using visual reasoning.**

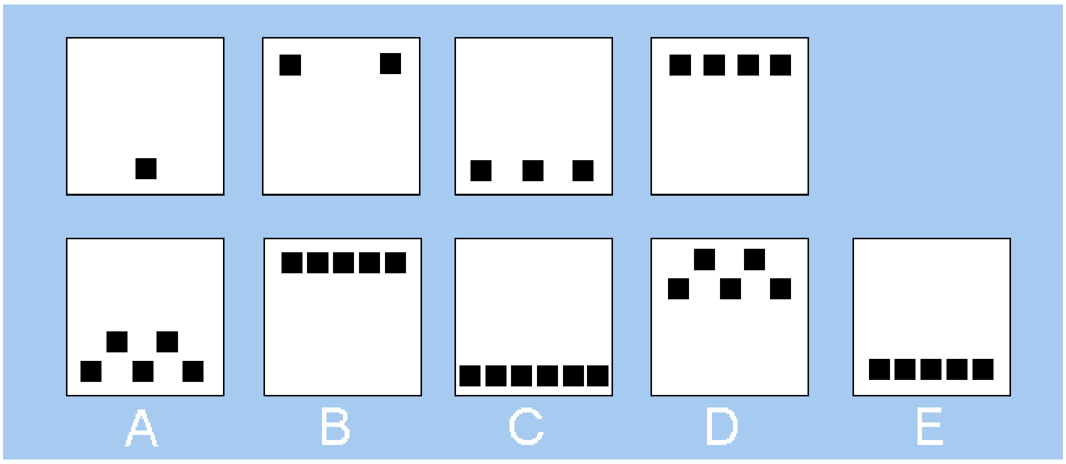
---

**Instructions**:

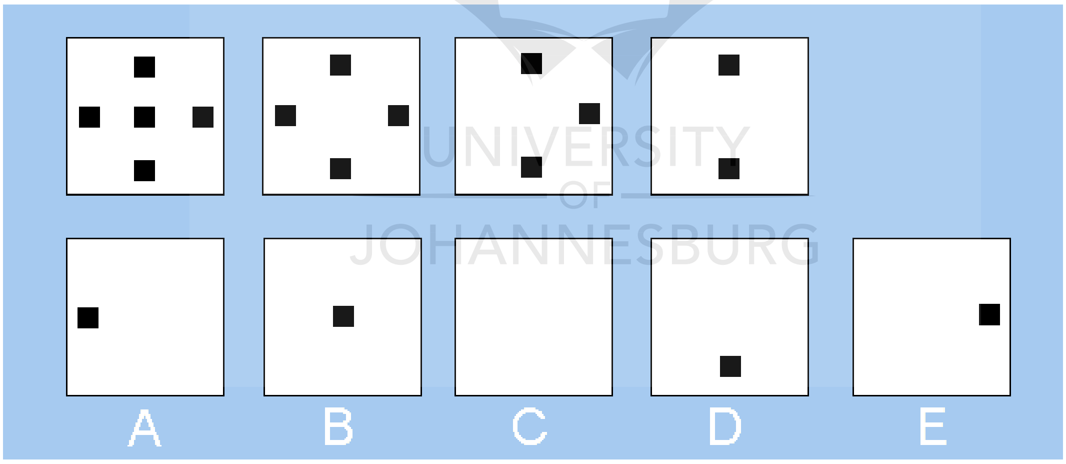
In the first example questions the top row of four boxes make up a series from left to right. You have to decide which of the 5 boxes underneath, marked A to E, will be the next in the sequence. For example in the **first example**, the top four boxes have 1, 2 , 3 , and 4 dots respectively. Obviously, the next box in the sequence will have 5 dots, which is box D.




Therefore the answer is **1. D**

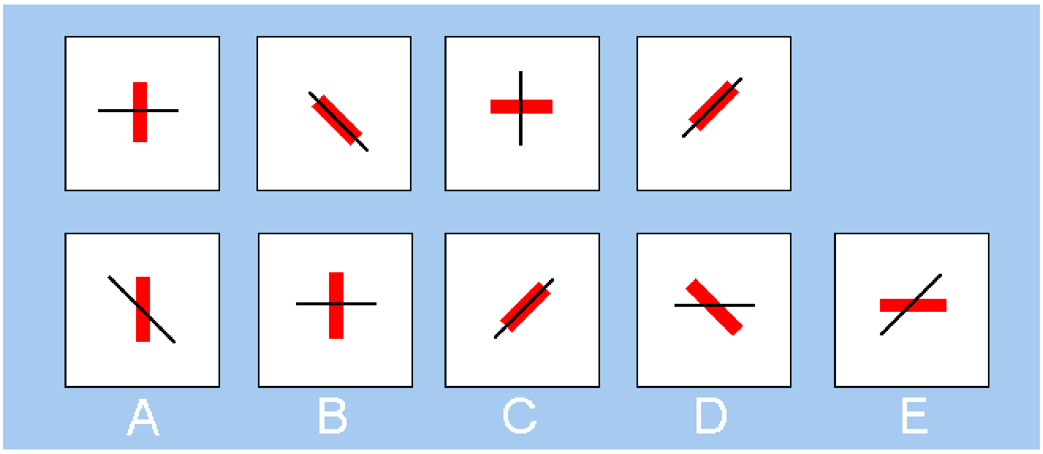



1.___________



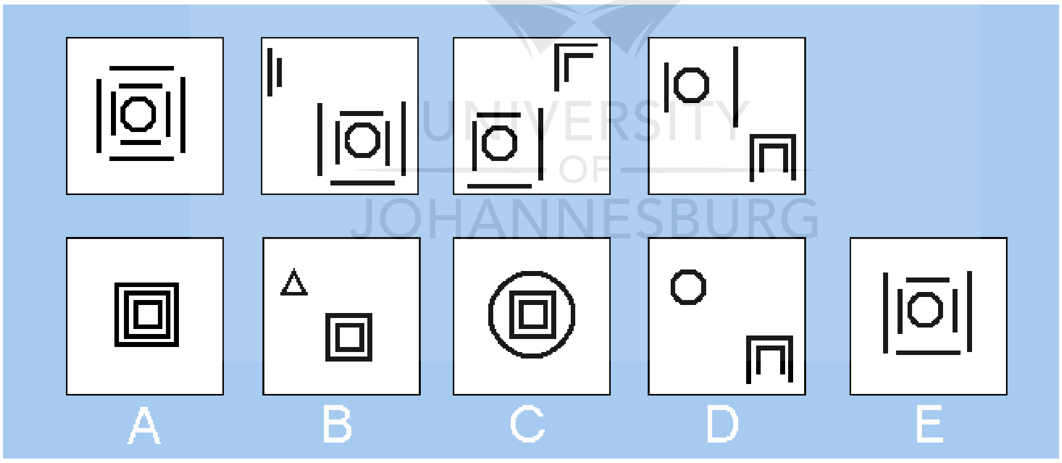



2.___________

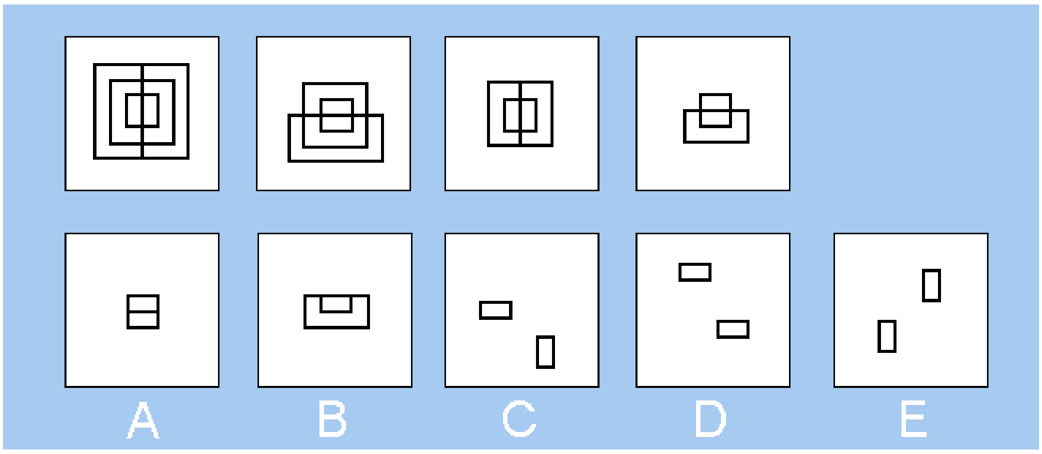



3.___________

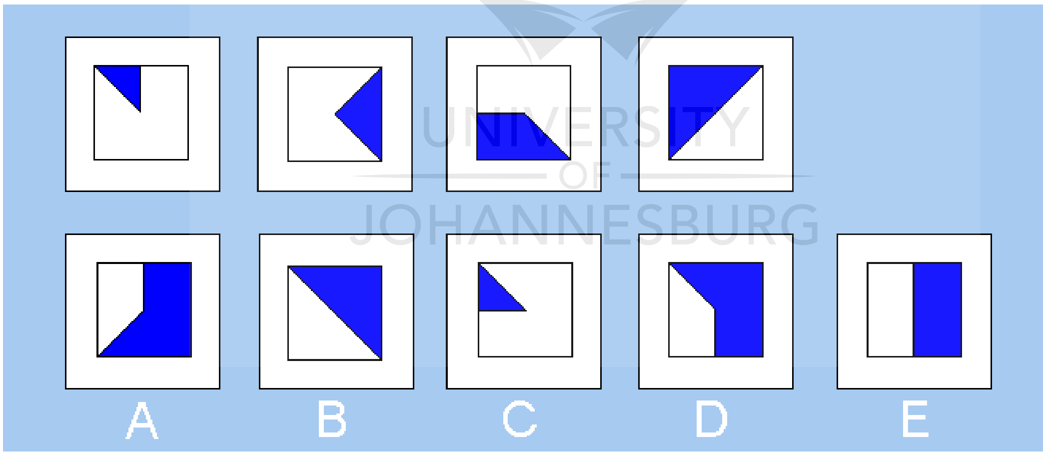





4.___________

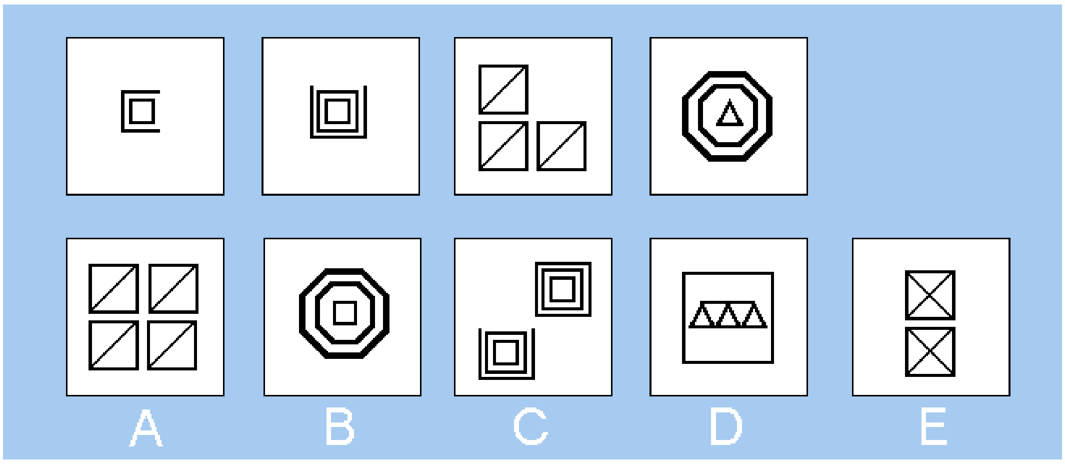



5.___________



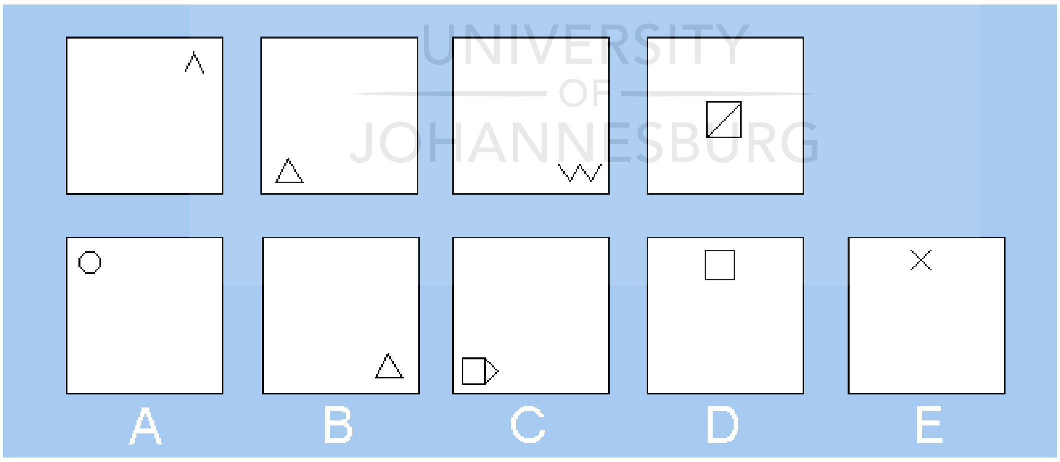



6.___________

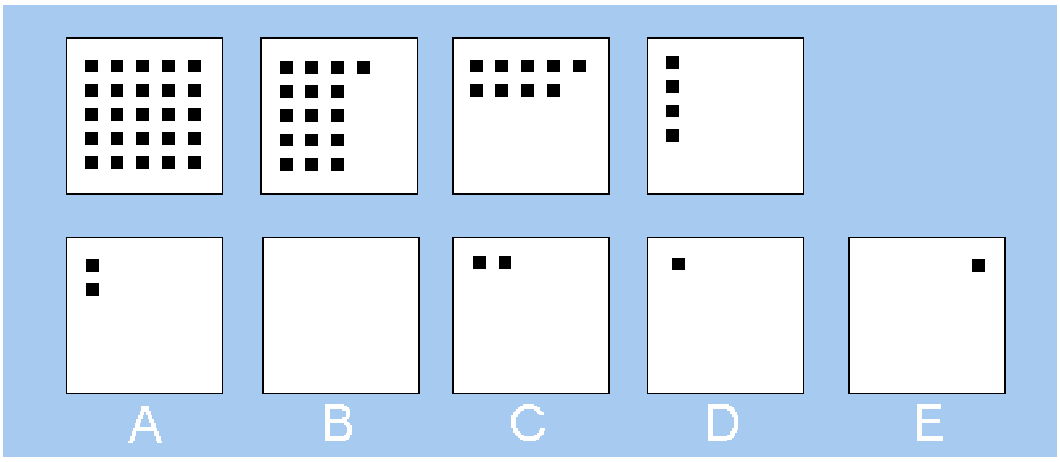



7.___________

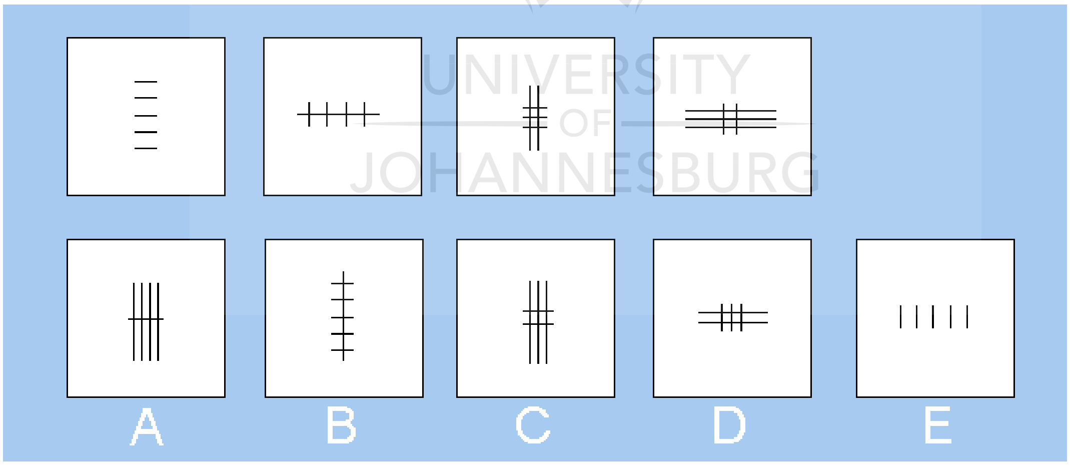





8.___________




9.__________






10.__________

## NON-VERBAL REASONING TEST

## Answers

1. 1 black at bottom, 2 black top, 3 black bottom, 4 black top, 5 black at bottom: **E** is the answer

2. Each time one dot is removed so the last box should show one dot. This must be answer **D** as it is the only box with a dot in the same location (South) as in the previous box.

3. The black line rotates by 45 degrees clockwise each time. The thick red line rotates 45 degrees anticlockwise each time, so the answer is **B.**

4. Each box contains 8 straight lines and a circle
   Only answer **C** contains 8 straight lines and a circle

5. The innermost two rectangles are vertical, then horizontal, then vertical again then horizontal,
   So in the answer they must both be vertical therefore **E** is the answer

6. Each box increments by one blue segment (one eight of the square). So there are 4 segments in box four (half the square is filled). So there must be 5 blue segments (5/8th of the square) in the answer which leaves us with A or D.
   But the diagonal edge of the first segment is also rotating clockwise by 90% each time, so it should be aligned NW in the answer. therefore the answer is **D**

7. The first box has 7 straight lines, the second 11, the third 15, the fourth 19 and so the fifth box will have 23 lines, so the answer is **C**

8. 15) The first box has two lines, the second 3, the third 4, the fourth 5 and so the fifth box will have six lines, so the answer is **C.**

9. The first square has 25 black squares, the second has 16, the third 9, the fourth 4 and so the 5th will have one square (reducing sequence of the square numbers 25, 16, 9, 4, 1). Also squares are removed from the right and from the bottom, so the final square will be in the top left corner, thus the answer is **D.**

10. The first box has 5 short lines and no long lines, the second box: 4 short & 1 long, the third box: 3 short & 2 long, the fourth box 2 short and 3 long. So each time there is one more long line and one less short line, so in the fifth box there will be 1 short and 4 long lines: the answer is **A.**

## APPENDIX E

Name & Surname ________________________________________ Student No. ____________

# COMPUTER PROGRAMMING APTITUDE TEST

The computer programming aptitude tests consists of a **standard battery of tests** assessing competencies such as numerical reasoning, logical reasoning, non-verbal reasoning and verbal logic which are required in technical computing jobs.

---

## NUMERICAL REASONING TEST



The test has **10 questions** and you will have **20 minutes** to do them. Please use the **SCRAP PAPER** at the back of the test and a **CALCULATOR** for working out answers.

Some questions have pictures or tables which you will need to refer to. These are displayed **above** the question.

---

1. 83 -17 = 56 + ?

   ________________________________________

2. If oranges cost 5 for 75c how many can you buy for R2,70 (assuming they can be bought singly)?

   ________________________________________

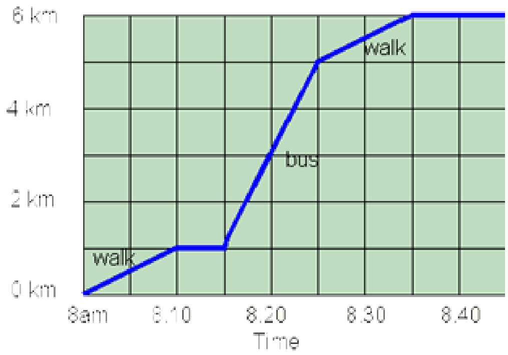
3. A car left Johannesburg at 7:12 am and arrived in Klerksdorp, 180 kilometers distance at 10:57 am. What was its average speed in kilometers per hour?

   ________________________________________

4. You get a wage increase of 4% plus an extra R5 per week. Your present wages are R250 per week. What will your new wage be?

   ________________________________________

**Use the diagram below to answer the following questions:**




A student walks to the bus stop to catch a bus to the university. He then walks from the bus stop at the university to the cafeteria arriving there at 8:35am.

5. How far does the student walk in total (in Kilometres)?

_____________________________________________

6. What is the average speed of the bus?

_____________________________________________

7. Which is the largest fraction: 3/4 7/8 4/5 7/9 7/10

_____________________________________________

**Use the information below to answer the following questions:**

**A taxi drive works 46 weeks of the year and gets an average of 70 customers per week which average 4 kilometers each at 90 cents per kilometer.**

**His expenditure is as follows:**

| | |
|---|---|
| **Car service/repair/insurance:** | **R1,250,00 per year** |
| **Petrol costs:** | **R0.06 per kilometer** |
| **Mortgage costs:** | **R250,00 per month** |
| **Other expenditure – food/electricity etc:** | **R125 per week** |

8. What is the total income in Rands of the taxi driver for the whole year?

_____________________________________________

9. What is his average excess of income over expenditure per month to the nearest Rand?

_____________________________________________

10. A driver drives 8 km South then 6 km W. and 2 km S. again. She then drives 3 km E. to avoid a traffic jam before driving 6 km N. How many kilometres is she from her starting point?

_____________________________________________

# NUMERICAL REASONING TEST

## Answers

1) **83 -17 = 56 + ?**
66 = 56 + ?
? = 66 - 56 = **10**
**Answer = 10**

2) **If oranges cost 5 for 75c how many can you buy for R2.70? (Assuming they can be bought singly)**
5 oranges cost 75c, therefore one orange costs 75 divided by 5 = 15c
R2.70 is the same as 270c.
Therefore the amount of oranges you get for 270c
= 270 divided by the cost of one orange
= 270 divided by 15
= **18 oranges**
**Answer = 18 oranges**

3) Time taken = 3 hours 45m = 3.75 hours (15/4 hours if you prefer fractions).
Speed = distance / time taken = 180 / 3.75 = **48 km/ph**
**Answer = 48 km/h**

4) Present wage = 250
4% of 250 = 4 x 2.5 = R10
Therefore new wage = 250 + 10 + 5 = **R265**
**Answer = R265**

5) **How far does the student walk in total?**
One km from 8.00 to 8.10 and another km from 8.25 to 8.35 = **2 km** total
**Answer = 2km**

6) **What is the average speed of the bus?**
Student gets on bus at 8.15 am at 1 km from home.
Student gets of bus at 8.25 am at 5 km from home.
Therefore bus travels 4 km in 10 minutes
The bus would travel six times as far in one hour = 6 x 4 km in one hour = **24 kmph**
**Answer = 24 kmph**

7) **Which is the largest fraction: 3/4 7/8 4/5 7/9 7/10**
3/4 = 0.75, **7/8 = 0.875**, 4/5 = 0.8, 7/9 = 0.777..., 7/10 = 0.7
**Answer = 7/8**

8) **What is the total income of the taxi driver for the whole year?**
Average fare = 4 x 90c = R3.60
Income per week = 70 fares at R3.60 each = 70 x 3.60 = R252
Income for 46 weeks work = R252 x 46 = **R11,592**
**Answer = R11 592**

9) **What is her average excess of income over expenditure per month to the nearest pound?**
Income p.a. = R11,592 Expenditure p.a. = R11,523 (answers to previous questions)
Therefore excess of income over expenditure = R69 p.a. = R69 / 12 per month = R5.75 = **R6 per month** to nearest Rand
**Answer = R6**

10) **A driver drives 8 km South then 6 km W. and 2 km S. again. She then drives 3 km E. to avoid a traffic jam before driving 6 km N. How many kilometres** is she from her starting point?
Total distance driven South = 8 + 2 - 6 km = 4 km
Total Distance driven West = 6 - 3 km = 3 km
This makes a right angled triangle where the distance from her starting point is the hypotenuse.
Using Pythagoras Theorem: "In any right triangle, the area of the square whose side is the hypotenuse (is equal to the sum of the areas of the squares of the other two sides"
4 squared + 3 squared = hypotenuse squared
16 + 9 = 25 = hypotenuse squared
Therefore hypotenuse (distance from starting point) = square root of 25 = **5km**
Or a simpler method is to see that the distances make a 3, 4, 5 triangle so the distance from start is 5 km
**Answer = 5kms**

## APPENDIX F

Name & Surname ________________________________________ Student No. ____________

# COMPUTER PROGRAMMING APTITUDE TEST

The computer programming aptitude tests consists of a **standard battery of tests** assessing competencies such as numerical reasoning, logical reasoning, non-verbal reasoning and verbal logic which are required in technical computing jobs.

---

## VERBAL LOGIC TEST



The test has **10 questions** and you will have **20 minutes** to do them. **Please use the SCRAP PAPER at the back of the test and a CALCULATOR for working out answers.**

Verbal logic tests your **ability to think logically, analytically and numerically, and also to extract meaning from complex information.**

---

1. Debbie, Kimi and Michael have Ferraris.
   Michael also has a BMW.
   Jensen has a Mercedes and a Audi.
   Rubens also has a Mercedes.
   Debbie also has a Mini.
   Rubens has just bought a Toyota.

   Who has the fewest cars?

   ________________________________

2. Wayne is double the age of Ann and one third as old as Joe who will be 48 years old in 6 years.
   How old is Ann?

   ________________________________

3. Hanif, Horace, Hilary and Hannah are students.
   Hanif and Horace speak Tswana, whereas the others speak English.
   Horace and Hannah speak Zulu.
   Everyone except Hanif speaks Xhosa.

   Who only speaks English and Xhosa?

   ________________________________

4. Simon, Cheryl and Dannii are all going by train to Pretoria to watch a singing competition.
Cheryl gets the 2.15 pm train.
Simon's train journey takes 50% longer than Dannii's.
Simon catches the 3.00 train.
Dannii leaves 20 minutes after Cheryl and arrives at 3.25 pm.

When will Simon arrive?

______________________________

5. 5 bricklayers can lay a total of 50 bricks in 30 minutes. How many bricklayers will be required to lay a total of 60 bricks in 18 minutes?

______________________________

6. An old treasure map has the following instructions:

Stand next to the black rock and face West.
Walk 20 yards and then turn 90 degrees clockwise.
Walk another 10 yards and then turn 45 degrees anticlockwise.
Walk another 15 yards, reverse your direction and walk 5 yards back.
Turn 135 degrees clockwise and walk another 10 yards.

In which direction are you now facing?

______________________________

7. One third of a number is four times eleven. What is half of that number?

______________________________

8. David, Sally and Ben live in three adjoining houses. Ben has a black cat called Fred, Sally has a white dog whereas David has a red parrot. Sally has a neighbour with a red door. The owner of a four legged animal has a blue door. Either a feline or fishy owner has a green door. Ben and Sally are not neighbours. Whose door is red?

______________________________



9. You are holding a children's party for 7 children and have asked the children what activities they would like at the party. Because of time constraints, you will only have time for two activities, but want to make sure that everyone gets either their first or second choice. The children and activity preferences are as follows:

| | | | | | |
|---|---|---|---|---|---|
| Rachel | Face painting | Magician | Bouncy castle | Ball games | Disco |
| Debbie | Bouncy castle | Ball games | Face painting | Magician | Disco |
| Sunita | Magician | Face painting | Magician | Disco | Ball games |
| Ben | Ball games | Face painting | Disco | Magician | Bouncy castle |
| Mia | Disco | Magician | Face painting, | Bouncy castle | Ball games |
| Jo | Magician | Bouncy castle | Disco | Face painting | Ball games |
| Amel | Face painting | Ball games | Bouncy castle | Magician | Disco |

Which two activities should you choose?

______________________________

10. A farmer has to get to his herd of sheep quickly as he has been told they are being attacked by a dog. His sheep are on the other side of a steep hill. He can run over the hill (3 km's) at 4 km's an hour, or take his tractor via an old dirt track which is 5 km's at an average of 6 km's an hour or he can drive his car along a very narrow winding road but this is 14 km's and he can only go at 18 km's an hour on average.

Which method should he choose?

______________________________

## VERBAL LOGIC TEST

## Answers

| Q | Answers | Test answers plus working |
|---|---|---|
| 1. | Kimi | Debbie, Kimi and Michael have Ferraris. Michael also has a Reliant Robin. Jensen has a Mercedes and a Model T. Rubens also has a Mercedes. Debbie also has a Bugatti Veyron. Rubens has just bought a Toyota Prius. Who has the fewest cars?<br><br>Debbie: Ferrari, Bugatti Veyron<br>**Kimi: Ferrari**<br>Michael: Ferrari, Reliant Robin,<br>Jensen: Mercedes, Model T,<br>Rubens: Mercedes, Toyota Prius |
| 2. | 7 | Wayne is double the age of Fernando and one third as old as Didier who will be 48 years old in 6 years. How old is Fernando?<br>Didier is 48-6 =42 years old<br>Wayne is 1/3 of 42 years old = 14<br>Fernando is half 14 years old = **7 years old** |
| 3. | HILARY | Hanif, Horace, Hilary and Hannah are students. Hanif and Horace speak Chinese, whereas the others speak Arabic. Horace and Hannah speak Albanian. Everyone except Hanif speaks Esperanto.<br>Hanif speaks Chinese;<br>Horace: Chinese, Albanian and Esperanto;<br>Hilary: Arabic and Esperanto;<br>Hannah: Arabic, Albanian, and Esperanto<br>Who only speaks Arabic and Esperanto? **HILARY** |
| 4. | 4.15 | Simon, Cheryl and Dannii are all going by train to London to watch a singing competition. Cheryl gets the 2.15 pm train. Simon's train journey takes 50% longer than Dannii's. Simon catches the 3.00 train. Dannii leaves 20 minutes after Cheryl and arrives at 3.25 pm. When will Simon arrive?<br>Dannii leaves at 2.35 arrives 3.25 therefore 50m journey<br>Simon's journey takes 75m therefore **arrives at 4.15** |
| 5. | 10 | 5 bricklayers can lay a total of 50 bricks in 30 minutes. How many bricklayers will be required to lay a total of 60 bricks in 18 minutes?<br>1 bricklayer lays 10 bricks in 30 minutes = 1 brick every 3 minutes<br>60 bricks would take 1 bricklayer 180 minutes<br>Therefore 180/18 bricklayers are required to lay these in 18 minutes =**10** |
| 6. | W | An old treasure map has the following instructions:<br><br>Stand next to the black rock and face West. Walk 20 yards and then turn 90 degrees clockwise<br>Walk another 10 yards and then turn 45 degrees anticlockwise. Walk another 15 yards, reverse your direction and walk 5 yards back. Turn 135 degrees clockwise and walk another 10 yards. In which direction are you now facing? N<br><br>Ignore the distances (these are red herrings) , the direction you face is all that matters!<br>W, N, NW, SE, **W** |
| 7. | 66 | One third of a number is four times eleven. What is half of that number?<br>1/3 =44<br>Number = 132<br>Half 132 = **66** |
| 8. | Athos | Athos, Portos and Aramis live in three adjoining houses. Aramis has a black cat called d'Artagnan, Portos has a white dog whereas Athos has a red herring. Portos has a neighbour with a red door. The owner of a four legged animal has a blue door. Either a feline or fishy owner has a green door. Aramis and Portos are not neighbours. Whose door is red?<br>Portos, white dog, blue door<br>**Athos,** red herring, **red door**<br>Aramis, black cat, green door |

<table>
<tr>
<td>9.</td>
<td>Magician and Ball games</td>
<td>You are holding a children's party for 7 children and have asked the children what activities they would like at the party. Because of time constraints, you will only have time for two activities, but want to make sure that everyone gets either their first or second choice. The children and activity preferences are as follows:
<table>
<tr><td>Rachel</td><td>Face painting</td><td>Magician</td><td>Bouncy castle</td><td>Ball games</td><td>Disco</td></tr>
<tr><td>Debbie</td><td>Bouncy castle</td><td>Ball games</td><td>Face painting</td><td>Magician</td><td>Disco</td></tr>
<tr><td>Sunita</td><td>Magician</td><td>Face painting</td><td>Magician</td><td>Disco</td><td>Ball games</td></tr>
<tr><td>Ben</td><td>Ball games</td><td>Face painting</td><td>Disco</td><td>Magician</td><td>Bouncy castle</td></tr>
<tr><td>Mia</td><td>Disco</td><td>Magician</td><td>Face painting,</td><td>Bouncy castle</td><td>Ball games</td></tr>
<tr><td>Jo</td><td>Magician</td><td>Bouncy castle</td><td>Disco</td><td>Face painting</td><td>Ball games</td></tr>
<tr><td>Amel</td><td>Face painting</td><td>Ball games</td><td>Bouncy castle</td><td>Magician</td><td>Disco</td></tr>
</table>
Which two activities should you choose? Magician and Ball games.<br>
You only need to look at the second and third columns to make sure that everyone gets their first or second choice.</td>
</tr>
<tr>
<td>10.</td>
<td>Run</td>
<td>A crofter has to get to his herd of sheep quickly as he has been told they are being attacked by a dog. His sheep are on the other side of a steep hill. He can run over the hill (3 miles) at 4 miles an hour, or take his tractor via an old dirt track which is 5 miles at an average of 6 miles an hour or he can drive his car along a very narrow winding road but this is 14 miles and he can only go at 18 miles an hour on average.<br>
Which method should he choose?<br>
Running 3 miles at 4 mph takes 45 minutes<br>
Driving the tractor for 5 miles at 6 mph takes 50 minutes<br>
Driving the car for 14 miles at 18 mph takes 47 minutes<br>
Therefore he should run.</td>
</tr>
</table>

# APPENDIX G

UNIVERSITY OF JOHANNESBURG

**ETHICS CLEARANCE**

Dear G Barlow-Jones

**Ethical Clearance Number: 2013-032**

Re: Learning to programme: Finding congruence between the life-world of students and the practices of programming

Ethical clearance for this study is granted subject to the following conditions:

- If there are major revisions to the research proposal based on recommendations from the Faculty Higher Degrees Committee, a new application for ethical clearance must be submitted.
- If the research question changes significantly so as to alter the nature of the study, it remains the duty of the student to submit a new application.
- It remains the student's responsibility to ensure that all ethical forms and documents related to the research are kept in a safe and secure facility and are available on demand.
- Please quote the reference number above in all future communications and documents.

**The Faculty Academic Ethics Committee has decided to**

☒ Grant ethical clearance for the proposed research.
☐ Provisionally grant ethical clearance for the proposed research
☐ Recommend revision and resubmission of the ethical clearance documents

Sincerely,

Prof Geoffrey Lautenbach
**Chair: FACULTY ACADEMIC ETHICS COMMITTEE**
11 June 2013

## APPENDIX H

Tshwane University of Technology

Research Ethics Committee

*The TUT Research Ethics Committee is a registered Institutional Review Board (IRB 00005968) with the US Office for Human Research Protections (IORG# 0004997) (Expires 19 Jan 2014). Also, it has Federal Wide Assurance for the Protection of Human Subjects for International Institutions (FWA 00011501) (Expires 31 Jan 2014). In South Africa it is registered with the National Health Research Ethics Council (REC-160509-21).*

October 22, 2013

REC Ref #: 2013/10/005
Name: Barlow-Jones G
Student #: UJ Student

Ms G Barlow-Jones
Department of Science and Technology Education
Faculty of Education
University of Johannesburg

Dear Ms Barlow-Jones,

**Decision: Final Approval**

**Name:** Barlow-Jones G
**Proposal:** *Learning to program: Finding congruence between the life-world of students and the practices of programming*
**Qualification:** PhD, Information and Communication Technology (ICT) in Education, University of Johannesburg
**Supervisor:** Prof D van der Westhuizen



Thank you for submitting the revised project documents for ethics clearance by the TUT Research Ethics Committee (REC). In reviewing the application, the comments and/or notes below are tabled for your consideration, attention and/or notification:

- **Proposal, Data Collection Strategy**
  - The REC takes note of the intended data collection strategy which will involve the use of 12 tutors (3rd and 4th year students, University of Johannesburg) as fieldworkers. Also, the REC takes note that Ms Jacqui Chetty (UJ) will be involved in supervising and training these tutors as to what is expected of them in terms of confidentiality and ethical research conduct; including the TUT REC requirement that each fieldworker enters into a confidentiality agreement with the researcher.
- **Aptitude Test**
  - The revised biographical section is in order and duly noted.

The Chairperson of the Research Ethics Committee of Tshwane University of Technology reviewed the revised project documents on October 22, 2013. **Final approval** is granted to the study. The decision will be tabled at the next REC meeting on November 18, 2013 for notification.

The proposed research project may now continue with the proviso that:

1) The researcher/s will conduct the study according to the procedures and methods indicated in the approved proposal, particularly in terms of any undertakings and/or assurances made regarding informed consent and the confidentiality of the collected data.
2) The proposal (inclusive of the applicable information leaflet/s, informed consent document/s, interview guide/s and/or questionnaire/s) will again be submitted to the Committee for prospective ethical clearance if there are any substantial changes from the existing proposal, particularly if those changes affect any of the study-related risks for the research participants.
3) The researcher will act within the parameters of any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.

***Note:***

*The reference number [top right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants.*

**Annual review:**

1. The formal ethics approval of all research projects need to be renewed on an annual basis.
2. The current ethics approval expiry date for this project is **31 December 2014**.
3. No research activities may continue after the ethics approval expiry date indicated on the formal Research Ethics Committee approval letter.
4. The Research Ethics Progress Report (electronic copy available at the following website: http://www.tut.ac.za/Other/rninew/ResearchEthicsCommittees/Pages/default.aspx) constitutes an application for such ethics approval renewal and must be submitted to the REC by **November 1, 2014**.



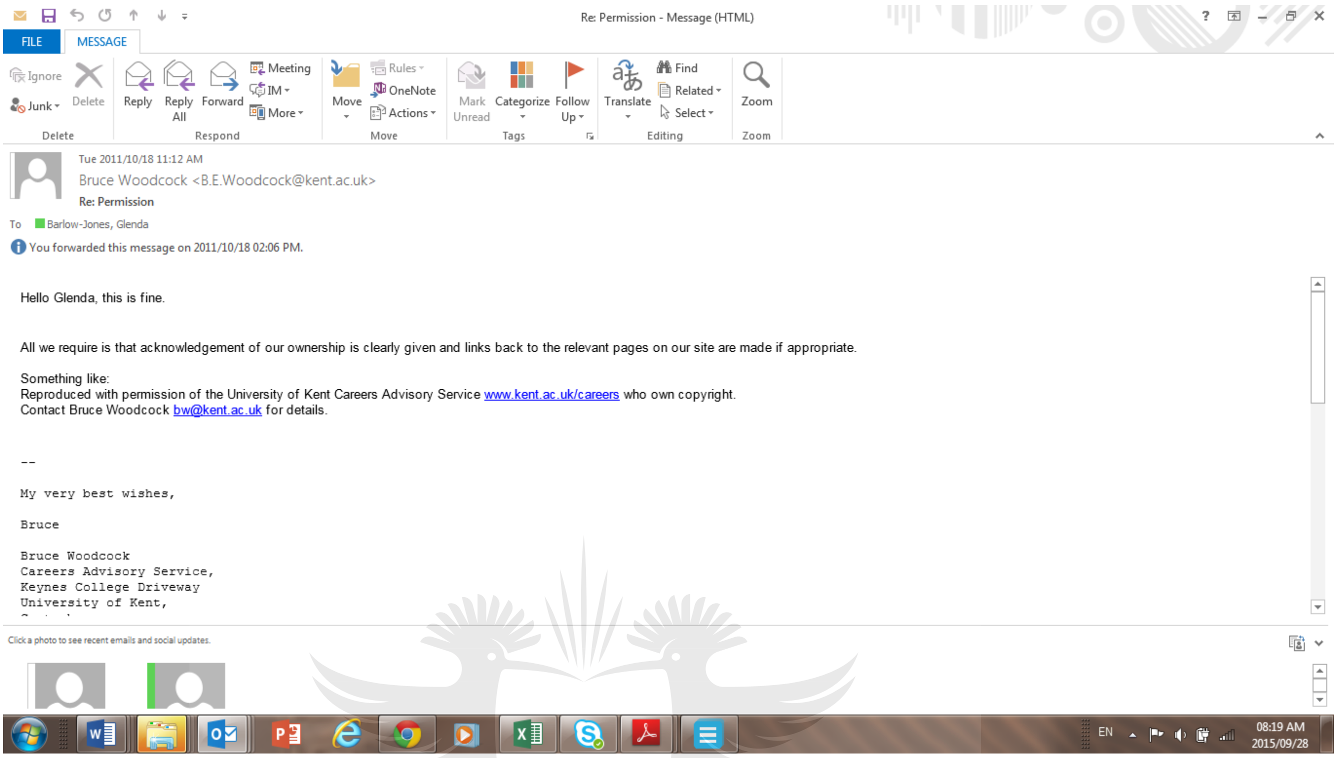
Yours sincerely,

**WA HOFFMANN (Dr)**
Chairperson: Research Ethics Committee
[Ref#2013=10=005=Barlow-JonesG]

*We empower people*

Tel. 0861 102 422, Tel. (012) 382-5154, Fax (012) 382-4409, www.tut.ac.za • The Registrar, Private Bag X680, Pretoria 0001

# APPENDIX I



Re: Permission - Message (HTML)

Tue 2011/10/18 11:12 AM
Bruce Woodcock <B.E.Woodcock@kent.ac.uk>
Re: Permission
To Barlow-Jones, Glenda
You forwarded this message on 2011/10/18 02:06 PM.

Hello Glenda, this is fine.

All we require is that acknowledgement of our ownership is clearly given and links back to the relevant pages on our site are made if appropriate.

Something like:
Reproduced with permission of the University of Kent Careers Advisory Service www.kent.ac.uk/careers who own copyright.
Contact Bruce Woodcock bw@kent.ac.uk for details.

--

My very best wishes,

Bruce

Bruce Woodcock
Careers Advisory Service,
Keynes College Driveway
University of Kent,

# APPENDIX J

**APPENDIX K**