The influence of student engagement on the performance of first-year mathematics students

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It all starts here ™

Dedicated with love to my husband,

Waldo.

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ABSTRACT

Student engagement, specifically in higher education, is an important field of research, which can help to improve the learning of students, as well as other anticipated outcomes. Student engagement is a complex concept and according to different researchers, consists of different components.

In this study, several facets of student engagement were explored, and the aim of this two-phase sequential, mixed method research is to determine the influence, which student engagement has on the performance of first-year mathematics students in their first semester at the North-West University, Potchefstroom Campus. The National Survey of Student Engagement (NSSE) divides student engagement into five facets: level of academic challenge, active and collaborative learning, supportive campus environment, enriching educational experiences and student-staff interaction.

A pilot study was done by administering a modified National Survey of Student Engagement (NSSE) to ascertain whether the adjusted questions in the questionnaire, specifically for mathematics students, were correctly formulated.

An explanatory sequential design mixed method research was used. The quantitative research was conducted during the first phase. The target population was 712 first-year Mathematics students and data were collected from a study population of 304 students who voluntarily completed a questionnaire. The second phase was the qualitative research where data were generated by means of individual, semi-structured interviews to explain the quantitative data further. The selection of the interviewees was done by the researcher.

Descriptive statistics, confirmatory factor analyses and linear regressions were done to analyse the quantitative data. The analysis of the qualitative data was done with the digital analysis software programme Atlas.ti.

The most significant results of this study are as follows: The Grade 12 Mathematics mark was the most noteworthy predictor for the Mathematics first-year module mark. Revision of class notes and assignments, perseverance to solve mathematics problems and academic help from tutors influenced mathematics performance. However, class preparation, the amount of hours studied, academic help from lecturers and peers and visiting the Mathematics centre did not have a significant effect on Mathematics performance. The Mathematics module mark of students who were involved in too many social activities tended to be low and most of the participants experienced the Mathematics module as difficult.

Results from this research indicate that *Level of academic challenge* emerged as the most prominent facet of student engagement. This is meaningful in the area of mathematics education at tertiary level since it illustrates that the complexity of mathematics directly impacts the students' engagement on a multitude of levels. This facet, in turn, influences the other four facets of student engagement and ultimately the student's overall performance in Mathematics.

KEY WORDS: student engagement, higher education, Mathematics performance, tertiary level, factors, first-year Mathematics performance.

OPSOMMING

Studentebetrokkenheid, spesifiek in hoër onderwys, is ’n belangrike navorsingsveld wat kan help om die leer van studente, asook ander verwagte uitkomste te verbeter. Studentebetrokkenheid is ’n komplekse konsep en bestaan volgens verskillende navorsers uit verskillende komponente.

In hierdie studie is verskeie fasette van studentebetrokkenheid ondersoek, en die doel van hierdie twee-fase opeenvolgende, gemengde metode navorsing is om die invloed van studentebetrokkenheid op die prestasie van Wiskundestudente in hulle eerste jaar, in die eerste semester aan die Noordwes-Universiteit, Potchefstroomkampus te bepaal. Die “National Survey of Student Engagement” (NSSE) verdeel studentebetrokkenheid in vyf fasette: vlak van akademiese uitdagings; aktiewe en samewerkende leer, ondersteunende kampusomgewing, verrykende onderrigervaring en student-dosentinteraksie.

’n Loodsstudie is gedoen deur ’n aangepaste “National Survey of Student Engagement” (NSSE) voor te hou om te verseker dat die gewysigde vrae in die vraelys, spesifiek vir Wiskundestudente, korrek geformuleer is.

’n Verduidelikende, opeenvolgende gemengde navorsingsmetodeontwerp is gebruik. Die kwantitatiewe navorsing is in die eerste fase uitgevoer. Die teikenpopulasie was 712 eerstejaar Wiskundestudente en data is van ’n studiepopulasie van 304 studente wat die vraelys vrywillig voltooi het, ingesamel. Die tweede fase was die kwalitatiewe navorsing waar individuele, semi-gestruktureerde onderhoude gevoer is om die kwantitatiewe data verder te verduidelik. Die navorser het die studente gekies met wie onderhoude gevoer is.

Beskrywende statistiek, bevestigende faktorontleding en lineêre regressies is gedoen om die kwantitatiewe data te analiseer. Die analise van die kwalitatiewe data is met behulp van die digitale analise sagtewareprogram, Atlas.ti. gedoen

Die betekenisvolste resultate van hierdie studie is soos volg: Die Graad 12-Wiskundepunt was die noemenswaardigste voorspeller van die eerstejaar Wiskunde-modulepunt. Hersiening van klasnotas en opdragte, deursettingsvermoë om wiskundeprobleme op te los en akademiese hulp van tutors, het Wiskunde-prestasie beïnvloed. Klasvoorbereiding, die aantal ure, gestudeer, akademiese hulp van dosente en medestudente en besoek aan die Wiskunde-sentrum, het egter nie ’n betekenisvolle uitwerking op Wiskunde-prestasie gehad nie. Die Wiskunde-modulepunt van studente wat betrokke was by te veel sosiale aktiwiteite het geneig om laag te wees en die meeste van die respondente het die Wiskundemodule as moeilik ervaar.

Resultate van hierdie studie bewys dat *Vlak van akademiese uitdaging* die prominentste faset van studentebetrokkenheid is. Hierdie bevinding is betekenisvol op die gebied van Wiskundeonderwys op tersiêre vlak, omdat dit illustreer dat die kompleksiteit van Wiskunde die studente se betrokkenheid op menige vlakke direk beïnvloed. Hierdie faset beïnvloed opeenvolgend die ander vier fasette van studentebetrokkenheid en uiteindelik die studente se algehele prestasie in Wiskunde.

SLEUTELTERME: studentebetrokkenheid, hoër onderwys, Wiskunde-prestasie, tersiêre vlak, faktore, eerstejaar Wiskunde-prestasie.

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CHAPTER 1

INTRODUCTIONS AND PROBLEM STATEMENT

1.1 Introduction and problem statement

It is general knowledge that the universities in South Africa have comparatively low performance rates and thus low throughput rates (CHE, 2013b:31-32). This implies that South Africa is experiencing a crisis situation in the teaching and learning in education in general, and therefore also in higher education. According to the Department of Higher Education and Training (DHET), the enhancement of teaching and learning is imperative to increase the performance rates of students at higher education institutions (DHET, 2012:41-43). Specifically, student engagement in higher education is an important field of research, which can help to improve the learning of students, as well as other anticipated outcomes. The researcher's experience as a first-year Mathematics lecturer at a university is that students generally do not engage enough or at all with their studies to enhance their performance in Mathematics. The purpose of this study, therefore, is to investigate the influence of student engagement on the performance of first-year Mathematics students.

Zepke *et al*. (2010:2) say that the following factors influence students' performance in general: employment, and family, social, cultural and personal factors. Student engagement in general has been researched extensively by a number of researchers (Chickering & Gamson, 1987; Gasiewski *et al*., 2012; Handelsman *et al*., 2005; Krause & Coates, 2008; Kuh *et al.*, 2006). Exploring the influence, which student engagement has on the performance of students has also been undertaken significantly (Anthony, 2000; Briggs *et al*., 2004; Crisp *et al*., 2009; Hailikari *et al*., 2008; Lee, 2014; McKenzie & Schweitzer, 2001; Schiefele & Csikszentmihalyi, 1995; Zepke & Leach, 2010). Student engagement influences students' performance in Mathematics, according to Briggs *et al.* (2004:8).

In the literature, student engagement is defined in different ways. According to Fredricks *et al*. (2004) (cited by Zepke *et al*., 2010:11), student engagement is defined as: "... a complex construct understood in different ways with many factors affecting it." Another definition of student engagement is: "Students' cognitive investment in, active participation in, and emotional commitment to their learning." (Chapman, 2003:1). Engagement, according to Krause *et al*. (2005:4), is the time, resources and energy, which students put into activities, which can enhance their learning at university. These activities can include:

- time the student spent on campus or studying, and
- the in- and out-of-class learning experiences,
- which connect the student to his/her peers in ways, which can be educationally meaningful and purposeful.

Student engagement is a complex concept and according to different researchers consists of different components. Laird *et al*. (2008:87) identify two components comprising student engagement. The first component is the amount of time and the degree of effort that students put into engaging with their studies. The second component is how the institution (university, college, etc.) provides resources such that students benefit from these activities. However, Handelsman *et al*. (2005:184) and Miller *et al*. (2011:53) identify four dimensions of student engagement: skills engagement, participation/interaction engagement, emotional engagement and performance engagement. In contrast to that, Fredricks *et al*. (2004), (cited by Gasiewski, 2012:231), talk about academic engagement with three dimensions: behavioural engagement, emotional engagement, and cognitive engagement. Academic engagement, according to Pike and Kuh (2005:283), can be represented by four scales: library experience, active and collaborative learning, writing experiences and interactions with faculty.

Bryson and Hand (2007) (cited by Zepke *et al.*, 2010:4) see student engagement through different lenses. Student motivation is the first lens while the second lens focuses on engagement in classrooms and institutions. The third lens focuses on the socio-political context for learning and the fourth lens on the impact of factors, such as the economic status of students and their family background.

Zepke (2011:1) says teachers and quality teaching are two factors, which influence how well students engage in learning. He suggests three research orientations, the first of which is theories, which focus on the students' personal growth, which is generated from within the student. The second orientation is more sociological, which focuses on the environmental factors, which influence student learning and the third research orientation is external influences. Pascarella and Terenzini (2005) (cited by Zepke, 2011:1) see the first two orientations as not separate and they acknowledge overlaps between the two orientations.

The results of the empirical analysis done by Coates (2007:132) characterise student engagement as collaborative, intense, passive or independent. These labels refer not to different enduring traits or student types, but rather to styles or states of engagement. A study done by Coates in 2006 (cited by Coates, 2007:124), suggests that the engagement of early-year students living on campus with their study, should be conceptualised in terms of nine qualities: active learning, academic challenge, beyond-class collaboration, constructive teaching, complementary activities, collaborative work, student and staff interaction, supportive learning environments and teacher approachability.

Horstmanshof and Zimitat (2007:705) view student engagement as having behavioural and psychological dimensions. These two dimensions were first used by Tinto (1993) (cited by Horstmanshof and Zimitat, 2007:705) and McInnis *et al*. (2000:21) in their studies. The behavioural dimension consists of students' academic conscientiousness in respect of their consistent study behaviour and seeking advice from teaching staff. The psychological dimension is a dimension of human functioning. It influences the actions and decisions of students and is non-conscious.

Different researchers identify different key factors, which influence student engagement:

- student motivation and effort (Schuetz, 2008:311,319);

- the way lecturers/teachers practice and relate to their students (Umbach & Wawrzynski, 2005:155);
- the roles of institutions (Porter, 2006:522);
- the socio-political context in which engagement and education take place (Yorke, 2006:12); and
- the influence of environmental factors, such as economic status and family background of students (Miliszewska & Horwoord, 2004) (cited by Zepke *et al.,* 2010:1-2).

In this study, several facets of student engagement will be explored. The National Survey of Student Engagement (NSSE) (Kuh, 2009:16-18) divides student engagement into five facets: level of academic challenge, active and collaborative learning, supportive campus environment, enriching educational experiences and student-staff interaction. Not much literature could be found on how student engagement influences the performance of students specifically in Mathematics (Grehan *et al.*, 2015 and Shearman *et al*., 2012). The main research question that will guide this study is: What is the influence of student engagement on the performance of first-year Mathematics students? The researcher will therefore specifically explore the influence of student engagement on the performance of first-year Mathematics students in their first semester according to the abovementioned five facets.

1.2 Research aims and objectives

The aim of the research is to determine the influence, which student engagement has on the performance of first-year Mathematics students in their first semester at the North-West University, Potchefstroom Campus.

The objectives of this study are to explore the influence of

- the level of academic challenge;
- active and collaborative learning;
- supportive campus environment; and

- enriching educational experiences and student-staff interaction on student performance.

1.3 Method of investigation

1.3.1 Research design

A mixed methods approach of qualitative and quantitative methods will be used. Creswell (2009:4) defines mixed methods research as: "... an approach to inquiry that combines or associates both qualitative and quantitative forms. It involves philosophical assumptions, the use of qualitative and quantitative approaches, and the mixing of both approaches in a study."

1.3.2 Measuring instruments

The National Survey of Student Engagement (NSSE) was modified to adapt to the South African environment. A pilot study was done by administering the modified NSSE to ascertain whether the adjusted questions, specifically for Mathematics students, in the survey, were correctly formulated. After the analysis of the data collected in the survey, individual, semi-structured interviews were held with six students at the beginning of the second semester of 2015. The researcher chose two students who were highly successful in WISN111 (Introductory Algebra and Analysis I), two students with average marks for WISN111 and two students who failed WISN111 to interview.

1.3.3 Data analysis

- The quantitative data collected in the survey will be analysed through the use of statistical methods.
- The qualitative data in the interviews will be done by transcribing the interviews and using the computer program ATLAS.ti for the coding of the interviews.

1.3.4 Participants

The target population for the quantitative research was the 712 first-year Mathematics students who took WISN111 at the Potchefstroom Campus of the North-West University, South Africa, in 2015. They were registered for Engineering, Natural Science, Business Mathematics and Informatics (BMI) and certain Commerce courses. Consent forms (see addendum 4) were given to the target population and 350 of the students gave their consent to take part in the research and completed the questionnaire. The modified survey was administered to the 350 first-year Mathematics (WISN111) students at the Potchefstroom Campus of the North-West University at the end of the first semester. There were 208 male and 96 female participants. The majority of the participants (51%) were 19 years old when they completed the questionnaire. The most popular type of residence was a dormitory or other on-campus housing where 50% of the participants resided (see Table 1, 3.4.1). Only those students who took first-year Mathematics for the first time in 2015, and who completed Grade 12 at a South African secondary school were considered for the study.

Six individual, semi-structured interviews were conducted with individuals who also participated in the quantitative phase of this study, in order to get the interviewee's experiences in the most truthful probable way. The researcher chose two students to interview who were highly successful in their first-year, first semester Mathematics, two students with average marks for their Mathematics and two students who failed their first-year, first semester Mathematics. The interviews were conducted at the beginning of the second semester of 2015. Each participant gave the researcher permission to make a recording of the interviews by completing a consent form (see addendum 4). To record the interviews, the researcher made audio recordings of each interview.

1.4 Reliability and Validity

Researchers aspire to choose an instrument that states individual results that are reliable and valid (Creswell, 2008:169). These two concepts necessarily go together in multifaceted ways, occasionally overlap and at other times are equally exclusive. If results are not reliable, they are not valid. Therefore, this implies that it is necessary for results to firstly be "stable and consistent" (Creswell, 2008:169) (reliable) and then meaningful (valid). In addition, the more reliable the results of an instrument are, the more valid the results may be. Consequently, the ultimate situation occurs when results are both reliable and valid.

The researcher made use of internal consistency reliability for the quantitative part of this study. That means that the scores of the individuals were internally consistent throughout the instrument's items. To check the internal consistency of the questionnaire, Cronbach's Alpha coefficient values were used. Cross-checking of codes was done by a person other than the researcher to ensure the reliability of the interviews. Content and construct validity (Creswell, 2008:172-173) were used to ensure that the individual's results from the questionnaire are significant, have value, and allow researchers to make valuable deductions from the sample being studied in respect of the population (Creswell, 2008:169). Numerous validity strategies were used by the researcher to advance the researcher's capability to evaluate the correctness of the qualitative results and also to convince readers of that correctness.

1.5 Ethics

By handing out a consent form to the target population, the participants were given the opportunity to voluntarily and without obligation complete the survey. The students' student number was asked, only because the marks of WISN111 were needed for the study. Although information is kept confidential, research sponsors and/or regulatory authorities may inspect research records. The students were, however, not identified in any way. The students could have chosen to withdraw from the study at any time. There was no penalty for non-participation or withdrawal from the study. There was no risk involved in the students' participation. The students may contact the researcher and supervisors to obtain a copy of the results should they be interested. Data are kept on the premises in locked storage according to university regulations for a period of five years.

The North-West University Research Ethics Regulatory Committee (NWU-RERC) approved the research. This implies that the NWU-RERC granted its permission that the research may be initiated, using the ethics number NW – 00192 – 14 – A3.

1.6 Chapters

Chapter 1: Introduction and Problem Statement

In this chapter the problem statement, the research aims and a brief discussion of the research of the study are outlined.

Chapter 2: Literature Overview

In this chapter an in-depth literature study of various factors influencing the performance of students in Mathematics and specifically the influence of student engagement is undertaken.

Chapter 3: Research Design and Methodology

In this chapter how data were collected, as well as an analysis thereof are discussed.

Chapter 4: Results

The quantitative and qualitative results obtained in the study are presented and discussed.

Chapter 5: Discussions, Conclusions, and Recommendations

In this chapter a discussion of the conclusions of the study and recommendations are given.

CHAPTER 2
LITERATURE OVERVIEW

2.1 Introduction

Although the influence of student engagement on the performance of students has generally been researched well, there is a gap in the research on student engagement in Mathematics. Not much literature could be found on how student engagement influences the performance of students specifically in Mathematics.

Thus, the literature study will address the following key aspects of this study:

- Defining student engagement (Zepke *et al*., 2010; Chapman, 2003)
- Elements of student engagement
- General factors influencing the performance of students (Crisp *et al*., 2009; Zewotir *et al*., 2011; Eng *et al*., 2010)
- General factors influencing the performance of students in Mathematics (Anthony, 2000)
- Student engagement influencing the performance of students (Kolari *et al*., 2006; Kuh, 2005; Zepke, 2011)
- Student engagement influencing the Mathematics performance of students (Anthony, 2000)

2.2 General definitions of student engagement

Student engagement is defined by Hu and Kuh (2002: 555) as “the quality of effort students themselves devote to educationally purposeful activities that contribute directly to desired outcomes”.

Krause *et al*. (2005:31) define student engagement as “... time, energy and resources students devote to activities designed to enhance their learning at university. These activities typically range from a simple measure of time spent on campus or studying, to in- and out-of-class learning experiences that connect students to their peers in educationally purposeful and meaningful ways.”

Student engagement, according to Kuh (2005:87), denotes two important characteristics. Firstly, it is student-driven: the amount of time and attempts students put into their learning and other academically focused actions. The second characteristic is institution-driven: how an institution arranges its sources and structures the curriculum, other learning opportunities, and support facilities to persuade students to become involved in activities that lead to the capabilities and results that create performance (dedication, fulfilment, learning and qualification).

A study done by Coates in 2006, suggests that the engagement of early-year students living on campus with their study should be conceptualised in terms of nine qualities: active learning, academic challenge, beyond-class collaboration, constructive teaching, complementary activities, collaborative work, student and staff interaction, supportive learning environments and teacher approachability. The results of the empirical analysis done by Coates (2007:132-133), characterise student engagement as collaborative, intense, passive or independent. These labels refer not to different enduring traits or student types, but rather to styles or states of engagement.

The diagram in Figure 1 illustrates the abovementioned typological model of student engagement styles of Coates.

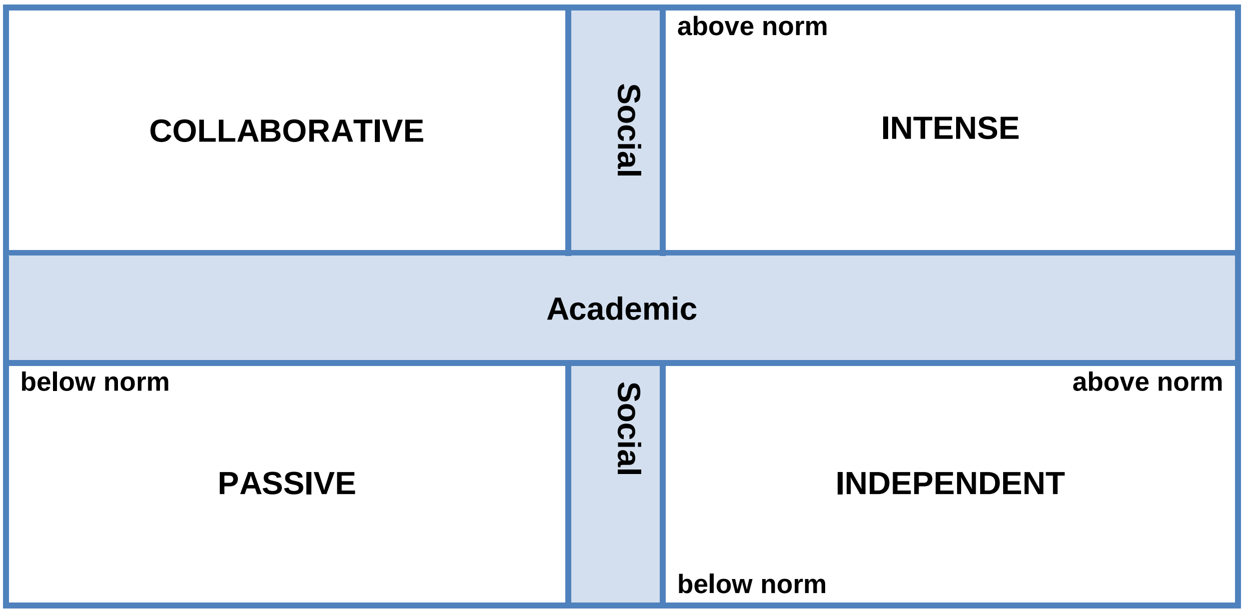

Figure 1: Typological model of student engagement styles

Students with an intense form of student engagement are extremely occupied with their study at the institution. They perceive themselves as active, inspired and creative students who work together with their peers in and out of class. Lecturers are easy to talk to and the students understand that their studying milieu can be open, helpful and inspiring. The students' style in relation to their education, which is more academic and not so much social, is an independent style. With this kind of style, students are likely to pursue demanding learning practice, they use feedback constructively to support their learning, and create discussions with lecturers. They see themselves as accomplices in an encouraging learning society. The collaborative and passive student engagement styles are in numerous ways the opposite of the independent and intense styles. The social traits of university work and life can be identified as the collaborative style of student engagement. Students with high levels of collaborative engagement echo the students' belief that they are valued within their institutional community, especially by taking part in wide-ranging out-of-class talent-progressive activities and interrelating with lecturers and peers. If a student has a passive style of engagement, he/she seldom participates in events and situations related with constructive learning (Coates, 2007:132-133).

Bryson and Hand (2007) (cited by Zepke *et al.*, 2010:4) see student engagement through different lenses. The first lens focuses on student motivation, the second on engagement in classrooms and institutions, the third on the socio-political context for learning and the last lens focuses on the impact of factors, such as the economic status of students and their family background. The first three lenses were chosen by Zepke *et al*. (2010:4) in their research because the three lenses focus mostly on institutional and non-institutional environmental factors, which emphasise their research question.

Laird *et al.* (2008:87) identify two components, which comprise student engagement. The first component is the amount of time and effort students put into engaging with their studies and other associated experiences, which influence their performance. The second component is how the institution (university, college, etc.) provides resources and gives such learning opportunities that students benefit from these activities.

According to Krause and Coates (2008:493), student engagement "focuses on the extent to which students are engaging in activities."

Gunuc and Kuzu (2015:587-589) perceive student engagement totally differently when compared with that of many other researchers. They examine student engagement with regard to two main elements: campus and class engagement. Three sub-aspects of each of these elements are identified. For campus engagement, the following three sub-aspects are classified: ideas of participation in societal interests, awareness of belonging and respecting university/education. The sub-aspects of respecting and awareness of belonging represent psychological engagement and the sub-aspect of participation implies social engagement. Class engagement includes students' cognitive, emotional and behavioural responses to in-class and out-of-class didactic endeavours.

The diagram in Figure 2 indicates the abovementioned student engagement elements and sub-aspects.

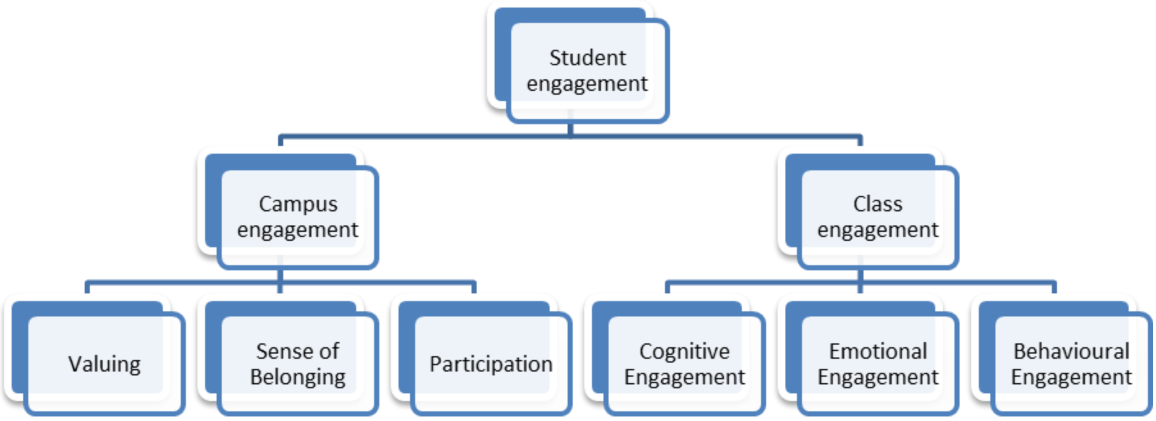

Figure 2: Student engagement elements and sub-aspects (Gunuc & Kuzu, 2015:589)

2.3 Elements of student engagement

Student engagement is a multidimensional concept. In the literature, many researchers have recognised numerous elements of student engagement: behavioural, social, cognitive, affective, academic, skills and performance engagement, as compiled by the researcher in Figure 3. Because student engagement is defined by many researchers in different ways, the different elements of student engagement will be discussed.

Figure 3: Elements of student engagement

2.3.1 Behavioural engagement

Behavioural engagement evokes the idea of involvement. It comprises of participation in academic and social or extramural activities and is considered essential for attaining progressive academic results and preventing attrition (Coates, 2007:122; Fredricks *et al*., 2004:60; Lee, 2014:177; Sheard *et al.,* 2010:1). Appleton *et al*. (2006:429) regard behavioural engagement as many different behaviours at the institution, such as showing up to diligently participate in academic or non-academic actions.

The behavioural dimension, according to Horstmanshof and Zimitat (2007:705), consists of students' academic conscientiousness in respect of their consistent study behaviour and seeking advice from teaching staff. This dimension was first used by Tinto (1993) (cited by Horstmanshof and Zimitat, 2007:705) and McInnis *et al*. (2000:21) in their studies.

Handelsman *et al*. (2005:187) and Miller *et al*. (2011:53) define behavioural engagement as participation or interaction engagement. They describe it as engagement that takes place in relation to others and with lecturers and taking part in class, for example asking questions in class, visiting the lecturer in his/her office to talk about the classes and taking part in discussions in small groups.

2.3.2 Social engagement

Pike and Kuh (2005:283) define social engagement as being represented by three scales: personal experience, student acquaintances and topics of conversations. If students spend more time on campus, the better

- their engagement with other students concerning their academic work;
- their enhancement of friendships at the institution;
- their pleasure of the socialization at the institution; and
- their feeling of fitting in to the academic group will be (Anderson *et al*., 2006; (cited by Whitton & Moseley, 2014:436); Yorke, 2006: 13).

2.3.3 Cognitive engagement

Cognitive engagement draws on the idea of speculation; it encompasses attention and motivation to apply the effort needed to grasp complex ideas and overcome demanding skills (Fredricks *et al*., 2004:60). Greene and Miller (1996:181-182) define cognitive engagement as the investment of students in learning with methods involving each student’s devotion to working hard and surpassing expectations. According to Coates (2007:122), cognitive engagement relates to participating in learning, the inspiration to learn, eagerness to utilise effort to learn challenging views and skills, and the use of plans.

2.3.4 Affective engagement

Affective engagement is indicated by some researchers as either psychological or emotional engagement. These meanings of the terms are therefore all the same. Affective engagement will now be explained according to the use of the different terms.

Emotional engagement involves the emotional adopting of class material and understandings by students (Handelsman *et al*., 2005:186-187; Miller *et al*., 2011:56). Examples, which illustrate emotional engagement, according to Handelsman *et al.,* are: students discover techniques to make module information useful to their lives, reflecting on module information between classes and having aspirations to study the material. According to Fredricks *et al*. (2004:60), emotional engagement includes positive and negative responses to lecturers, peers, academics and institution and is believed to create links to an institution and influence commitment to do the work. Horstmanshof and Zimitat (2007:705) view psychological engagement as a dimension of human functioning. It influences the actions and decisions of students and is non-conscious. This dimension was firstly used by Tinto (1993) (cited by Horstmanshof & Zimitat, 2007:705) and McInnis *et al*. (2000:21) in their studies. Kahu (2013:758) regards emotional engagement as an inner personal process, whereas according to Appleton *et al*. (2006:429) and Coates (2007:122), psychological engagement is indicated by feelings of belonging and interactions with lecturers and fellow students.

2.3.5 Academic engagement

Academic engagement, according to Pike and Kuh (2005:283), can be represented by four scales: library experience, active and collaborative learning, writing experiences and interactions with faculty. Pike and Kuh used the *College Student Experience Questionnaire (CSEQ)*, which asks questions based on the four above-mentioned scales.

Appleton *et al*. (2006:429) classify academic engagement as a dimension, which includes time spent working on a certain assignment, earned credits for graduation and finalising homework.

2.3.6 Skills engagement

Miller *et al*. (2011:55) and Handelsman *et al*. (2005:187) define skills engagement as the extent to which students exercise skills that will advance their learning, for instance making summaries of class lessons, learning often and doing class analyses (Handelsman *et al*., 2005:187).

2.3.7 Performance engagement

Performance engagement is an aspect of student engagement, which can be focused towards performance on scored materials and includes aspects, such as the significance students attach to achieving decent marks and being successful in tests (Handelsman *et al*., 2005:186-187; Miller *et al.*, 2011:53).

There are numerous factors, which influence the performance of students in general. Now that the different elements of student engagement have been discussed, a discussion of some factors influencing the performance of students in general will follow.

2.4 General factors influencing the performance of students

Performance at a tertiary institution is of increasing importance in the existing environment surrounding higher education (Mills *et al*., 2009:205). In South Africa, tertiary institutions, and especially universities, are changing in many significant ways: admission criteria are changing, the outcomes that students need to accomplish are now the explicit focus point of the programmes and the diversity of the student population is increasing. With these transformations, the responsibilities of universities are growing in terms of the academic programmes they offer and the academic performance and performance of students (Fraser & Killen, 2003:254).

Many researchers talk about the performance of students, some use success and others prefer academic performance. The term “performance” will be used in this study to avoid any confusion.

The general factors, which according to the literature influence the performance of students, will be discussed. The general factors are divided into four categories as seen in Figure 4, which was compiled by the researcher.

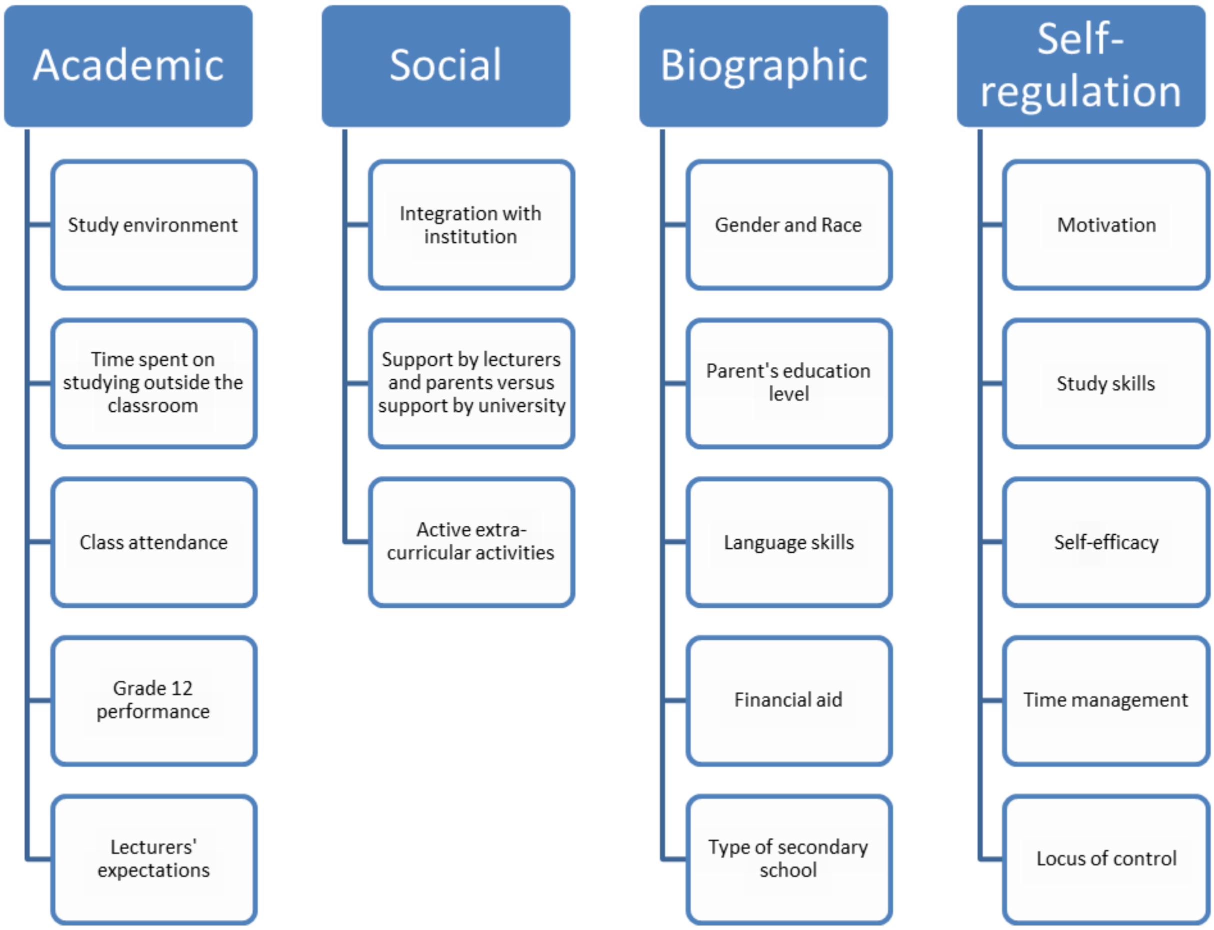

Figure 4: Categories of general factors influencing the performance of students

2.4.1 Academic factors

According to the literature, many different academic factors influence the performance of students at the tertiary level. Some of those factors will be discussed next.

2.4.1.1 Study environment

The effect, which the study environment has on students' performance, is evident in the literature. Study environment is defined by Steyn and Maree (2003:51) as: "Study environment includes aspects relating to social, physical and perceived environment." Zewotir *et al*. (2011:1241) found that students not living in a residence on the campus of the University of KwaZulu-Natal (UKZN), South Africa, are more likely to perform poorly in their first year and are even failing. According to Lizzio *et al*. (2002:27), the students' study environment was a greater predictor of academic performance at university than prior performance at school.

An academic support programme can also ensure a positive study environment for students to perform well. First-year medical students who were not in an academic support programme had a greater possibility to fail as opposed to this *status quo* in the Faculties of Humanities, Development and Social Sciences and Management Studies (Zewotir *et al*., 2011:1241). In the mentioned study, students that are on level 1 at UKZN, are students who did not yet pass a minimum number of modules (Zewotir *et al.*, 2011:1235). The academic support programme used by Bail *et al.* (2008:58-59), enrolled students who had proven academic necessity and were either a first-generation student or qualified for a need for financial aid. This academic support programme presented numerous facilities and events meant to focus on the needs of the students, such as financial aid and academic guidance, to prepare for specialised programmes and other occupational preparation and to assist with academic development actions.

The size of a class/lecture can have a significant positive or negative influence on a student's performance. Research conducted by Cook and Leckey (1999:168-169) shows that many students have idealistic ideas about the volume of work expected of them and class sizes when they arrive at university. The students arrive having studied at schools with small class sizes and where teachers were easily available. They are therefore poorly prepared for studying at university with the large class sizes and lecturers not as available to students because of a diversity of non-teaching activities. Fenollar *et al*. (2007:885) concluded that class size had a positive influence on determination and a negative intended influence on academic performance. However, the unintended positive influence of class size on academic performance via determination was not meaningful.

2.4.1.2 Time spent on studying outside the classroom and part-time working

Working part-time while studying can have a major impact on the performance of students. There is no explicit correlation between the total amount of time students spent working during a given week and academic performance or the total amount of time students spent studying outside the class (Nonis & Hudson, 2006:156). The influence of occupational obligations and students' workload is to some extent supported by the hypotheses of McKenzie and Schweitzer (2001:30). It would appear that full-time students with no occupational obligations have higher average marks than full-time students with part-time occupational obligations. The full-time students who have part-time occupational obligations are recognised as those students with the lowest average marks.

Lack of preparation for class can have an impact on academic failure according to both the qualitative and quantitative part of Zulu's (2008:40) research. Most of the students indicated that they looked over their assignments more than once before they submitted them. Fewer students gave their completed work to one of their fellow students for review. It seems as if students do not do prescribed class readings, which indicates that they go to class unprepared. Parker (2006:146) found, contrary to Nonis and Hudson (2006:156) that the time spent on studying outside the classroom is a convincing predictor of academic performance.

2.4.1.3 Class attendance

The lack of attending lectures frequently and consistently by students and also the effect it has on students' performance has been discussed extensively in the literature. Fraser and Killen's (2003:260) research confirms the fact that recurring class attendance is highly prone to ensuring performance, according to a questionnaire given to students and lecturers about factors influencing performance and failure. Because of the required character of school attendance in which students were asked to duplicate things they were told in class, students indicated that regular class attendance influenced performance. The high rating of class attendance by lecturers is because they see classes as an opportunity for them to deliver knowledge to the students, which will be tested in examinations.

Most of the students and lecturers who took part in Zulu's (2008:37) research at a South African university indicate that not attending classes is one of the important factors, which influences the students' failure rate. It seems as if class attendance is an important factor that influences students' academic performance positively.

The majority of the respondents in Tahir and Naqvi's (2006:7) research indicated that they attended classes between 91% and 100% of the time. The students with a class attendance rate of 80-90% are only a few of the respondents. Students attending classes frequently achieve higher average marks in comparison with those students who are not attending classes (Ali *et al.,* 2009:86; Marburger, 2001:105; Steenkamp *et al*., 2009:133). Thatcher *et al*. (2007:658) also confirm that students who "always" attend classes indicate statistically noteworthy academic performance benefits in contrast to students who "seldom" or "never" attended classes.

The research of Van Walbeek (2004:880) was not conclusive regarding the influence of class attendance on academic performance in the introductory microeconomic course at UCT (University of Cape Town). He found that class attendance on its own is not a worthy predictor of academic performance. The students' performance in Grade 12 is generally a significantly better predictor of academic performance.

2.4.1.4 Grade 12 performance and prior knowledge

The Grade 12 marks, which students have obtained and the prior knowledge of subjects they need at tertiary level, seem to influence the students' performance, according to the literature. In the research done by Keeve *et al.* (2012:147) they found that the Grade 12 performance of students provides the greatest individual contribution to academic performance. The prediction of McKenzie and Schweitzer (2001:29) that university admittance marks are a noteworthy forecaster of students' academic performance at the end of the first semester are confirmed by their research. Students who gain access to university with high admittance marks will probably continue to achieve high academic performances at university. Mills *et al.* (2009:213) conclude that academic performance of first-year students is mainly affected by Grade 12 marks. This finding is significant as it emphasises the value of prior academic performance. Byrne and Flood (2008:209) also found that prior academic performance has a strong relationship with first-year academic performance, especially in Accounting at an Irish university.

Van Rooy and Coetzee-Van Rooy (2015:31,42) go further by saying that the average Grade 12 grades above 65% are a valuable predictor of the academic performance of students at the North-West University, South Africa. The average Grade 12 grades below 65% can therefore not be a beneficial predictor of academic performance at university.

The relationship between students' first-year tertiary marks and their performance in their final year at secondary school showed that there were major disparities in the learning capabilities and levels of knowledge between most of the students (Watterson *et al*., 2013:1).

However, Mashige *et al*. (2014:561) found a poor relationship between Grade 12 marks in Mathematics, Physics and Life Sciences and the first-year Optometry modules of the University of KwaZulu-Natal's students. These results confirm the fact that the National Senior Certificate results of South Africa contradict expertise and conceptual shortcomings of the Grade 12 school-leavers. Lizzio *et al*. (2002:35) also found that the students' Grade 12 performance marks were positive, but a poor predictor of their academic performance at university. The commerce students at UCT who were in the Academic Development Programme (ADP), who attained fairly high adapted Grade 12 marks, an A, B or C mark for Mathematics (Higher Grade) and who studied Physical Science (Higher Grade), achieved a better average first-year mark (Smith *et al*., 2012:55). Most of the students in the ADP attended working-class and rural schools. They took English as an extra language and most of the students were first-generation students in their families (Smith *et al*., 2012:45). The Grade 12 marks were also only a relatively strong predictor of pass/fail at university, according to Mitchell *et al*. (1997:386).

Just a few of the Financial Accounting students at the University of Stellenbosch, South Africa, who took part in the study by Steenkamp *et al*. (2009:125-127) indicated that not having Accounting as a subject at secondary school had influenced their academic performance in Financial Accounting negatively. These perceptions of the students are contradictory to what one would suspect they would say. After testing for the impact of the factor of prior knowledge of the Accounting subject at secondary school, which influences the performance of students in the module, the conclusion was drawn that the majority of the students were successful in the

Accounting module. Parallel to that, not as many students who did not have Accounting at secondary school were successful in the particular module. Contrary to the conclusions of Steenkamp *et al*. (2009:127), Byrne and Flood (2008:209) found that there is no significant relationship between prior knowledge in Accounting at secondary school and the students' academic performance at university in financial and management Accounting modules.

It is evident that prior knowledge is important for first-year academic performance, which then influences the chance of staying at, relocating at, or dropping out of the tertiary institution (Allen *et al*., 2008:662).

2.4.1.5 Lecturers' expectations

When setting assessment tasks, lecturers expect particular performances from students. In both studies done by Fraser and Killen (2005:35), students position a low importance on understanding the expectations of the lecturers, but still believe that the expectations are "unrealistically high". The direct criteria of the lecturers' expectations are those that the students are probably believed to be "unrealistically high", but it may have less impact on students' performance than the indirect criteria. The conclusions made by Fraser and Killen suggest a sound need for lecturers to have suitable expectations of their students, for them to formulate these expectations directly and to give reasons to their students why there are expectations.

2.4.2 Social factors

There are many social factors influencing the performance of students. Three of these factors will be discussed.

2.4.2.1 Integration with institution

The projection of McKenzie and Schweitzer (2001:29) that the integration of students with the institution will be a major predictor of academic performance is true, but the relationship is a negative one. High levels of integration into the institution indicated by the students are inclined to result in poorer average marks by those students who indicate low levels of integration. This finding is contradictory to Tinto's (1975:96) model of integration that proposes that integration is fundamental for optimal results at university.

Strayhorn (2006:1295) and Tinto (1993) (cited by Bitzer & Troskie-De Bruin, 2006:121) distinguish between academic and social integration. Strayhorn finds that academic integration is positively correlated with academic performance, but social integration is negatively correlated with the first-generation students' marks. Tinto (1993) (cited by Bitzer & Troskie-De Bruin, 2004:121) indicated that during the student's year at an institution, his/her integration into the institution's social and academic milieu, determines his/her commitment level to the institution. The characteristics of the students entering the institution influence the level of their preliminary commitment to the institution. These characteristics comprise individual qualities (e.g. race, gender and academic competence), family background characteristics (e.g. educational level of their parents, socio-economic status) and pre-university training proficiencies (e.g. secondary school academic performance, participation in secondary school events).

2.4.2.2 Support by teachers and parents versus support by university

At school, learners receive solid support from their parents and teachers who advise them on how to study and give them bases of external inspiration. In the university environment, students are primarily away from their homes, and because of fewer contact sessions at university, their learning is not as structured as at school (Cook & Leckey, 1999:169).

2.4.2.3 Active extracurricular activities

In general, social activities have a tendency to influence students' academic performance considerably, and not in a positive way. Interestingly, the positive correlation between the average marks of the students and their participation in extracurricular activities proves that students who engage zealously in extra-curricular activities achieve higher average marks (Ali *et al.,* 2009:86).

2.4.3 Biographical factors

Students' characteristic factors, such as their gender, race, their parents' education level, the language skills of the students, the type of secondary school attended and the financial aid the students will need to study at a tertiary institution also exert a meaningful influence on their performance. These factors will now be discussed.

2.4.3.1 Gender and race

The influence of gender and/or race on the academic performance of students at higher institutions has been researched in many former studies. The conclusions of some of the studies are contradictory, as mentioned below.

According to Zewotir *et al*. (2011:1240), being female does not have any influence on the poor performance of first-year students in most of the faculties at the University of KwaZulu-Natal. However, at the same institution in the Education Faculty, the chance of a female student not passing her first year is higher than that of the male students. Mills *et al.* (2009:214) and Allen *et al*. (2008:661) found in their studies that first-year academic performance is related to gender, and females' marks are particularly higher than male students' marks. According to Byrne and Flood (2008:208), gender has no noteworthy relationship with first-year academic performance in accounting at an Irish university. Van der Merwe (2006:154) confirms that there is not a remarkable relationship between gender and the performance in the microeconomic courses at the Durban Institute of Technology. Ebenuwa-Okoh (2010:102) also concluded that there is no noteworthy contrast in the relationship between male and female students' academic performance.

Regardless of the females' lower university admission marks and under-portrayal in most departments, the female undergraduate students of the Middle East Technical University in Ankara, Turkey, performed better than their male counterparts during their university years (Dayioğlu & Türüt-Aşik, 2007:273). In contrast, Van Welbeek (2004:881) found that female students' performance was noteworthy worse in multiple-choice questions than that of their male counterparts in a first-year Economics course at UCT. However, there was an irrelevant relationship between gender and essay-type questions.

In South-Africa from 2008-2013, however, more female students enrolled in higher education institutions than male students and on average the female students also outperformed their male counterparts (Council of Higher Education, 2013a:3,11).

Race also had an influence on academic performance in the research of Allen *et al*. (2008:661). African-American students had lower first-year average marks, but also a better chance of staying at their initial institution. Zewotir *et al*. (2011:1240) confirm that for African students the possibility of failing in their first year is higher than for White students in some of the faculties at a university in South Africa. At the Faculty of Education, though, the failure rate for White students is higher than for Indian students. According to the Council of Higher Education (2013a:3,11), the most students enrolled for the period 2008-2013 in South-Africa at higher education institutions were African students. However, their passing rate was on average the lowest in comparison with other races. White students' pass rate was the highest on average although they were not the most students admitted to a higher education institution. Indian and Coloured students admitted to higher education institutions were in the minority. However, their average performance rate was higher than African students', but lower than White students' pass rate.

2.4.3.2 Parents' educational levels

The influence of the parents' educational levels is evident in most of the research that has been carried out. Students with a higher socioeconomic status had better first-year average marks (Allen *et al.*, (2008:661). Socioeconomic status is defined by Allen *et al*. (2008:661) as the parents' education levels and income.

The students of parents with no higher education seem to perform better than students with parents who have higher education (Keeve *et al.,* 2012:148). Since Pakistani fathers are absent from home because of long working hours, Tahir and Naqvi (2006:9) conclude from their research that students with literate mothers are performing better compared to students with uneducated mothers. Contradictory to Keeve *et al.'s* research, Ali *et al*. (2009:86) found that students with better average marks have parents with a higher education and a higher income.

2.4.3.3 Language skills

The language a student speaks and the competence of the student in that specific language influences the performance in some instances. The language skills of students supply an individual contribution to academic performance for the third-year curriculum group at the University of the Free State, South Africa (Keeve *et al.,* 2012:147). They investigated three academic factors (Grade 12 performance, language skills, and time spent on academic activities), which can predict academic performance together or individually. The results of the study done by Miller *et al.* (1998:106) indicate that distinguishing between English first and second language speaking students may be deceptive regardless of the fact that there are reliable disparities between English first and English second language students with respect to the students' academic performance. Their research also indicates that the allocations for Mathematics and English language competence are comparable for both English first language and English second language students. The disparity between English first language and English second language students therefore entails more than the language descriptions suggest. The results, therefore, give support to the disagreement that second language, rather than being an exact reason for under-preparedness, helps to worsen a more important instructive or cognitive problem.

A study done by Steenkamp *et al*. (2009:122,123) at the University of Stellenbosch, South Africa, concluded that most of the students indicated that the reason for their insufficiency of performance was that there were no classes presented in English. From the data, the following conclusion can also be made: Afrikaans-speaking students had a statistically noteworthy higher academic performance in comparison with English-speaking students. The academic performance of the students at the North-West University, South Africa was not projected convincingly by language-related instruments such as performance in the National Benchmark Test (NBT), Test of Academic Literacy Level (TALL) or even Grade 12 language marks (Van Rooy & Coetzee-Van Rooy, 2015:42). Thus, even performance in English as a first additional language in Grade 12 did not have a strong relationship with academic performance at the university for the specific students.

2.4.3.4 Financial aid

Students' ability to pay for their university fees, accommodation, food, etc., by means of bursaries, loans or any other way, can have an impact on their academic performance. Financial aid, such as bursaries and loans that students in the Faculty of Engineering receive, influences the failure rates of students who study with a scholarship and it differs drastically (Zewotir *et al.,* 2011:1240). They found that for students studying with a scholarship (based on the performance of the student) there is a greater possibility of not failing in this faculty than for those with bursaries (based on the financial needs of the student). The type of financial aid that first-year students receive to pay university fees, predicts academic performance, according to Mills *et al.* (2009:214). According to the outcomes of this study, those students who pay their fees immediately are more successful than those whose fee payments are late. The findings of Allen *et al*. (2008:661) propose that first-generation and economically burdened students are more likely to leave tertiary education.

Contrary to the abovementioned research, the academic performance and financial status of students were found to have no noteworthy relationship, according to Ebenuwa-Okoh (2010:102). This result implies that even if students vary regarding their financial status, it is not revealed in their academic performance. A possible reason for this can be that students who have the financial aid to study have a tendency to spend on themselves rather than on academic events and books, which may improve their performance. The improvement in the authorisation of programmes, however, made it doable for the majority of the departments to have academic material in libraries. It is therefore probable for all students, regardless of their financial status, to have the same kind of admission to academic amenities. Hence, improved academic performance is a matter of individual fortitude rather than controlled by finances (Ebenuwa-Okoh (2010:102).

2.4.3.5 Type of secondary school (Urban versus rural/township schools)

In South Africa, there is a variety of types of secondary school where students come from when starting their tertiary education. Many students finished their secondary education at a public school, but going to private schools is becoming more customary these days in South Africa. The academic performance of students is linked to the kind of secondary school the students attended. Mills *et al.* (2009:213) found that, if all additional factors are taken into consideration, those students who went to public secondary schools have higher marks in their first year than those who attended private secondary schools. Evans and Farley (1998:5) also found that students' performance is substantially different given the type of secondary schools they attended. In all the subjects, except one, there was a noteworthy disparity in the outcomes of students who attended non-Catholic independent schools and those students who attended government schools in Australia. A significant indicator of performance is the school of origin, according to Mitchell *et al*. (1997:385), who did their research on the relationship between the Grade 12 examination and university performance in South Africa, from 1980-1991. They found that the average Grade 12 marks of the students from 21 schools in the previous Transvaal Education Department were nearly alike. These students had similar average Grade 12 marks from the same Grade 12 government department, but from diverse schools in that government department. In spite of this, the variance between their Grade 12 mark and their first-year mark was unrelated.

2.4.4 Self-regulation factors

"Self-regulated learning (SRL) refers to the self-directive processes and self-beliefs that enable learners to transform their mental abilities, such as verbal aptitude, into an academic performance skill, such as writing. SRL is viewed as *proactive* processes that students use to acquire academic skill, such as setting goals, selecting and deploying strategies, and self-monitoring one's effectiveness, rather than as a reactive event that happens to students due to impersonal forces" (Zimmerman, 2008:166-167).

2.4.4.1 Motivation

According to Mnyandu (2009:4), being motivated entails being encouraged to do something. From a learning perspective, Woodbridge and Manamela (cited by Mnyandu, 2009:4) define motivation as "…the willingness to engage in meaningful tasks". Therefore, motivation can be a major factor, which influences students' performance.

Ryan and Deci (2000:56, 60) distinguish between two types of motivation, namely intrinsic and extrinsic motivation. They define intrinsic motivation as the undertaking of an action for its innate fulfilment rather than for several distinguishable results. When a person is intrinsically motivated, such a person is encouraged to proceed for the enjoyment or contest involved rather because of outer stimulates, burdens, or incentives. Extrinsic motivation is a concept that refers to an action that is executed every time in order to accomplish the certain distinguishable effect.

One of the hypotheses of research done by Nonis and Hudson (2006:153,156), states that "the influence that behaviour has on academic performance would be higher for students with high levels of motivation than for students with low levels of motivation." This hypothesis is not confirmed in their study. However, they found that high levels of behaviour or motivation will not assure the anticipated performance.

Both lecturers and students who participated in the research by Fraser and Killen (2005:36) at two South African universities (University of Pretoria and University of South Africa), soundly agreed that motivation is a factor, which contributes to performance and thus the absence of motivation is a factor, which can cause failure. Goodman *et al.* (2011:383) also confirm with their study that there is an exact link between the motivation and academic performances of students at a university in the Western Cape, South Africa. A positive relationship between motivation and students' academic performance was also found by Sikhwari (2009:85) and Steenkamp *et al*. (2009:128). However, Coetzee (2011:98) found in her studies that the relationships between academic performance and motivation are very small. Therefore, there is not a noteworthy relationship between motivation and academic performance of the first-, second-, third- and fourth-year students at the University of the Free State, South Africa. Coetzee (2011:98) thus concluded that it appears that motivation does not have an influence on the academic performance of the students at the University of the Free State.

Self-discipline, which is a construct of motivation and which is a factor influencing performance, is ranked second and fourth respectively by the lecturers and students who completed the "performance" questionnaire for the research done by Fraser and Killen (2003:261). The factor "lack of self-discipline", which impacts on failure, is ranked second and fourth by the lecturers and students respectively. This is also confirmed by the research done by Fraser and Killen in 2005. Self-discipline, according to Allen *et al*. (2008:660), was a significant predictor of first-year academic performance with an effect size equivalent to that of prior academic performance. They therefore resolve that academic performance influences enduring admission. Self-discipline was also meaningfully related to academic performance, although more moderately (Charmorro-Premuzic & Furnham, 2003:245).

2.4.4.2 Study skills

The different skills students should have to study effectively and to be successful in their studies are an important factor, which must be considered when discussing factors influencing students' performance. Gadzella and Williamson (1984:923) define study skills as: "…may include a wide range of behaviours and attitudes, such as the use of time, ways of mentally storing and organising information, being motivated and concentrating on tasks undertaken".

According to the research done by Cook and Leckey (1999:169), some students have ill-chosen study skills because the limited choice of subjects at secondary level does not prepare the students sufficiently in subjects, such as Chemistry, Mathematics, and Statistics. Cook and Leckey go further by concluding that the assessment and instruction styles in schools may provide them with the improvement of a series of study skills, which continue into university, but which are no longer suitable for the more self-regulating study styles in a tertiary setting. The result of Al-Hilawani and Sartawi (1997:541-542) also revealed that students with high average marks have better study skills than students with low average marks.

2.4.4.3 Self-efficacy

A student's belief in him- or herself in terms of his/her own competencies is an essential aspect of self-regulated learning. Bandura (1997) (cited by Adeyemo, 2007:200) define self-efficacy as: "Self-efficacy is concerned with a person's beliefs in his or her capabilities to learn or perform behaviour at designated levels." Self-efficacy can effect academic inspiration, performance, and study.

Self-efficacy connects positively to academic performance, according to McKenzie and Schweitzer (2001:30). Those students who report high self-efficacy of performance attain higher than average marks and also have notably higher average marks than those students who report low self-efficacy of performance. According to Fraser and Killen (2003:260), students do not have a successful self-regulatory system, which includes self-efficacy. They rather see themselves functioning in a setting that is regulated mainly by others. Adeyemo (2007:208) also confirms that self-efficacy is an important factor, which influences academic performance. The connection between academic performance and self-efficacy can be explained as follows: students with a great consciousness of efficacy have the ability to take on more demanding assignments, prove intensified perseverance when confronting difficulties, appear to have a lower level of anxiety, engage more self-regulation approaches than their fellow students, and show better susceptibility for self-motivation.

2.4.4.4 Time management

Claessens *et al*. (2007:262) suggested the following definition of time management, based on previous literature: “behaviours that aim at achieving an effective use of time while performing certain goal-directed activities”. Their definition emphasises that time-use is not a purpose in itself and cannot be engaged in seclusion. Several goal-directed activities are the focus, such as accomplishing an academic task, which is done in a way that suggests efficient time-use.

The research done by Tahir and Naqvi (2006:6) indicates that less than half of the students in the sample studied daily and even fewer students studied close to examinations or tests. This indicates that more study hours are not positively correlated with better student performance (Tahir & Naqvi, 2006:9). Time management is also a problem for the students who participated in the research by Cook and Leckey (1999:167). Meticulous students are more likely to control their own learning by means of time management, and it is these drives that correlate with academic results (MacCann *et al*., 2012:622). Finding reveals that non-cognitive concepts may have an imperative part to play in continued learning.

In the “performance” and “failure” questionnaire completed by students and lecturers in the research done by Fraser and Killen (2003:260), the lecturers rate “Timely and regular examination preparation” third highest factor on the “performance” questionnaire, which can influence performance and students rated it tenth. “Inadequate or poor exam preparation” is ranked first by both the Iecturers and the students on the “failure” questionnaire, which can influence the students’ failure.

A lack of time management when studying was indicated by the students at the University of Stellenbosch as an apparent restrictive factor in respect of their academic performance (Steenkamp *et al*., 2009:124). This study has also shown that relaxation activities and part-time work can have an influence on the time management of the students. According to Parker (2006:146), students who studied more or less than three hours per week, performed better in the examinations than those students who spent less than an hour on studying.

2.4.4.5 Locus of control

The importance of the locus of control of students on the performance at tertiary level is outlined in the discussion, which follows below.

“Locus of control refers to a person’s beliefs about control over life events” (Gifford *et al*., 2006:20). There are two types of control belief, which are not inevitably equally exclusive: internal and external. Highly internal control beliefs include the idea that support is dependent upon one’s own actions or steady personal features. Highly external beliefs involve the idea that support is due to luck, chance or influential others outside one’s control (Ofori & Charlton, 2002:509).

According to Zulu (2008:38), students assigned their failure to both external and internal factors (locus of control). Some examples of internal factors are laziness, too many social events on campus, not succeeding to learn, students’ inability to balance their social life and academic obligations, etc. The absence of lecturers, insignificant lectures, students’ personal difficulties, the way assessment was done, a jam-packed examination timetable, etc. are some examples of external factors.

It appears from a study by Fraser and Killen (2003:260) that many of the students do not have an efficient self-directing system. Instead, they have a tendency to see themselves functioning in an environment that is controlled mainly by others. Students with an efficient self-directing system must be able to even out their needs for association with their needs for performance. They must also have a convincing sense of self-efficacy and must be able to be grateful for the difficulty of the situations they face. Lastly, the students must have a sound sense of perseverance and obtain some pleasure from academic accomplishments. Later research, which Fraser and Killen (2005:34) conducted with the same students as in their research in 2003, confirmed that there is a strong indication in both studies in which the students participated that they operate in a milieu that is not controlled by them. The factors "too many demands on students' time" and "lecturers with unrealistically high expectations" are convincing contributors to probable failure. The students also included "boring presentations by lecturers", "poor language abilities of lecturers" and "unclear assessment criteria" as factors, which indicate that there is a perception among students that the absolute control over performance or failure in their educational milieu is not in each student's hands.

The factors identified by students, which are within their own locus of control, and which are probable causes for low class attendance, are classes, which are early in the morning, tiredness, the pressures of student life and laziness (Steenkamp *et al*., 2009:129). Furthermore, locus of control was found by Gifford *et al*. (2006:23) as a significant predictor of academic performance of first-year students by using the students' end of the year collective average marks.

2.5 Factors influencing the Mathematics performance of students

As indicated in 2.4, there are many factors influencing the general performance of students at a higher education institution. In the next section, some factors, according to the literature, which have an influence on the Mathematics performance of students, will be discussed. The factors are again divided into four categories as shown in Figure 5, which was compiled by the researcher.

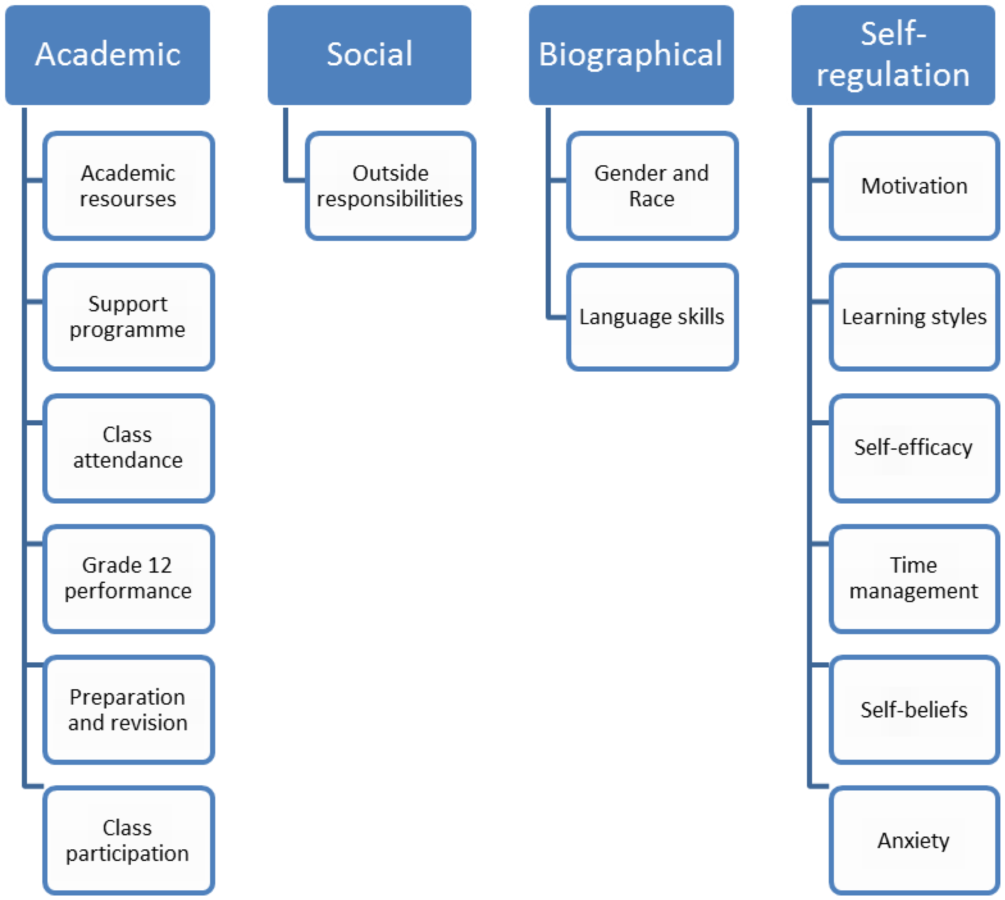

Figure 5: Categories of factors influencing the Mathematics performance of students

2.5.1 Academic factors

2.5.1.1 Class attendance

To attend a Mathematics class regularly is of imperative importance for students to perform well and for a deep understanding of the content of the Mathematics module. Louw (2009:376) found that class attendance was very important for performance in Mathematics. Anthony (2000:6) goes further by saying that frequent class attendance plays an important role in self-discipline to keep up with the work. The students answering the “failure” questionnaire of Anthony’s study stated that only half of them are present in all four Mathematics classes per week (Anthony, 2000:8). According to the research of Benford and Gess-Newsome (2006:108), students attending classes often are more likely to obtain passing grades and they also found that females attend classes more often than males.

According to research that has been carried out, class size is also a notable influence on Mathematics performance. Poor performance at the Tshwane University of Technology (South Africa) is influenced by factors, such as big class sizes, poorly educated school teachers, shortage of textbooks, the teaching language, acceptance criteria and insufficient study habits (Louw, 2009:368). Performance in Pre-Calculus is influenced by class size, but class size does not influence underachievement in the other Mathematics courses (average pass rate less than 70%), such as Calculus I, Mathematics II and Engineering Mathematics I, according to the research done by Eng *et al*. (2010:140). The reason for this can be the initial problem associated with the change from school to university that some students face, but as they advance to subsequent semesters, the students have learned how to handle big classes.

2.5.1.2 Grade 12 performance

The final Mathematics marks, which students obtained in Grade 12 is one of the most important predictors of Mathematics performance at tertiary level. The significance of Grade 12 performance is emphasised by Crowther *et al.* (1997:788), which links students' mathematical training to their first-year Mathematics and Engineering examination grades: A-level students do better in their first-year Mathematics tests/examinations, according to statistically proven results.

Rylands and Coady (2009:746) and Evans and Farley (1998:4) also conclude that the marks achieved in advanced levels of school Mathematics improve the performance of students' university modules. The results from Ryland and Coady's research indicate that 100% of the students who took Advanced Mathematics in secondary school passed the basic Mathematics subject at university and only 23% of students with an Elementary Mathematics background.

Hailikari *et al.* (2008:68) indicate that former training performance is a crucial factor, which influences student performance, both directly and also through prior knowledge. The research done by Murray (2013:157) indicates an adequate, but positive correlation between the students' previous Mathematics performance and their first-year Mathematics module performance. It indicates therefore that great grades in Grade 12 are correlated to great performance in a first-year Mathematics module. However, James *et al*. (2008:1047) concluded that NCEA (National Certificate of Educational Performance) Mathematics in New Zealand was a convincing predictor of performance in tertiary Mathematics modules. Thus, students' performance in first-year Mathematics modules had a strong relationship with their Mathematics performance in their final year at secondary school.

Eng *et al*. (2010:137) indicate in their study that SPM (Sijil Pelajaran Malaysia/Malaysian Certificate of Education) Mathematics clearly influenced the underachievement in Mathematics courses. This implies that there is a meaningful positive relationship between students' Mathematics course marks and their SPM Mathematics grades. Likewise, they found a more compelling positive relationship between the students' course marks and their SPM Additional Mathematics marks. The conclusion is that SPM Additional Mathematics influences the Mathematics performance of students at university to a considerable degree. Higher performance in Mathematics at university was related to advanced past performance, according to Parsons *et al.* (2009:65). The research by Tewari (2014:236) also indicates that students' Grade 12 marks in Mathematics are good predictors of academic performance of first-year courses at the University of KwaZulu-Natal, South Africa.

Another study done at the University of KwaZulu-Natal with first-year Optometry students indicated that Grade 12 Mathematics marks were in a relative relationship with first-year Mathematics and first-year Physics marks (Mashige *et al*., 2014:560). A much sturdier relationship was anticipated because Mathematics and Physics entail interpretation, analysis and the application of scientific perceptions.

A study done at the University of Transkei indicated that there was a noteworthy relationship between being successful in Grade 12 Mathematics and performance in a first-year Mathematics module (Mwamwenda, 2002:80). These results confirm what many other researchers have found, as mentioned previously.

Contrary to what abovementioned researchers found, Kizito *et al*. (2016:113) concluded that there is a positive, but poor relationship between Grade 12 Mathematics marks and performance in a first-year compulsory mathematical course at the University of the Western Cape for all students in the Statistical and Mathematical Sciences, Applied Geology, Computer Science, Physics and Chemistry programmes. A recommendation from these conclusions is that Grade 12 Mathematics marks should not be used as a singular predictor of Mathematics performance, specifically for this first-year mathematical course.

The prior knowledge students have of secondary school Mathematics and the level of Mathematics they took at secondary school play a vital role in the Mathematics performance of students at a higher education institution, and especially in their first-year Mathematics modules. Research done by Hailikari *et al.* (2008:68) indicates that domain-specific prior knowledge (knowledge of a certain subject field) is more of an indicator of student performance than the other factors, which are part of the study. One quarter of the students, participating in Varsavsky's (2010:1046) research, who had not done much or no Mathematics in their senior secondary years, were not successful in their first-year Mathematics course. These students' results were not really different from those students with an intermediate level of Mathematics (Varsavsky, 2010:1047). The students in Varsavsky's research coming to university with advanced mathematical abilities are more likely to expand their Mathematics studies.

Hourigan and O'Donoghue (2007:473) emphasised the under-preparedness of students in Mathematics at tertiary level in their research conducted in Ireland. They found that the preoccupation of teachers with the national examination results is the reason why many teachers see their main purpose as preparing their learners for this important examination. Regrettably, the teachers are restricting the learners' upcoming potential. This obsession with examination results usually causes rigid thinking, restricted competence in problem solving and non-existent self-confidence and determination in students. The restrictions of a teacher-centred, instructive approach, which has the national examination as the main focus, indicates that the standard secondary Mathematics experience disappoints in providing the learners with the required basics for tertiary level Mathematics modules. Whereas Mathematics courses at university level need self-regulating students who possess theoretical and versatile skills to resolve unknown problems, the acquisition of these vital skills is not encouraged in secondary schools.

The correlation between students' performance on the ACT (American College Testing), a theoretical algebra pre-test and the students' performance in a calculus module was researched by Reinholz (2007:7). The ACT is a standardised test for high school performance and college admissions in America. Mathematics, English, Reading, Science and Writing (optional) are the categories, which are tested. Reinholz found that there was no convincing correlation between ACT Math grades and performance in a calculus module for the specific population, which was unexpected. However, he believes that the ACT Math marks mainly reveal the students' routine pre-calculus abilities and that these abilities are not as vital to achieving in the calculus module as initially assumed (Reinholz, 2007:29).

Alfan and Othman (2005:340), two Malaysian researchers found that the performance of students in the business and accounting degrees are meticulously correlated to their prior performance in Mathematics in the SPM (Malaysia Certificate of Education) level. Attaining good marks for Mathematics enhances the students' quantity of knowledge, which can support the students agreeing to modules in the degree curriculum. Maree *et al.* (2003:408) indicated in their research done with first-year engineering students at the Rand Afrikaans University, (University of Johannesburg from 1 January 2005) South Africa that students who are failing are intelligent enough to perform well in Mathematics, but they do not have passable preparation in Mathematics.

According to the research done by Ubuz (2011:8), many fallacies held by students were already shaped at secondary school. This strengthens the fact that prior knowledge is a key factor, which influences students' learning and performance. Rylands and Coady (2009:741) also found that the secondary school Mathematics background of students, and not their admission marks to the tertiary institution had an intense influence on the students' pass rates in Mathematics modules.

2.5.1.3 Academic resources

A variety of academic resources is presently available to students to better their Mathematics knowledge and performance and to complete assignments, projects or even homework. There is a reasonable but positive relationship between students' academic resources and their performances in a first-year Mathematics course, according to Murray (2013:158). The respondents, and specifically the students of Anthony's (2000:6) research who completed the "performance" questionnaire, indicated that most of the students use support facilities to attain the aim to complete assignments. The students mostly look for a related question in the course material if they are stuck with questions in the assignments. They will also ask friends to help them and then search for external help, if necessary. Developing self-sufficient study groups by some of the students in the new university academic setting is inspiring to see.

2.5.1.4 Support programme

Mathematics support programmes are becoming more and more popular as an additional resource to support lecturers, tutors and/or the university, to enhance the students' Mathematics performance. Reinholz (2007:5) used a support programme, the ALEKS (Assessment and LEarning in Knowledge Spaces) Preparation for Calculus software in his research. This programme assesses students' knowledge state, which means that it defines which concepts the students are best prepared to learn, established on the priority correlations between concepts in the knowledge configuration. Depending on this outline, ALEKS delivers personally custom-made tuition through the studying method for each student. When ALEKS was included as a compulsory part of a calculus module, the programme failed to provoke any enhancement in students' performances (Reinholz, 2007:29).

Moreno and Muller (1999:34) also made use of a support programme, namely ESP (Emerging Scholars Program), which was constructed to assist constructive know-hows for calculus students. This programme offers the students a group varying in their ways of understanding with who the students can communicate their calculus knowledge. The students who are part of the ESP are those calculus students with a quantitative SAT (Scholastic Aptitude Test) mark of more than 500, and who passed in the top 10%-20% of their high school class. The research of Moreno and Muller (1999:46) concludes that those students who participated in the ESP while registered for calculus received higher calculus marks and were likely to enrol in the second semester calculus. They may also have greater chances of deciding on MSE (Mathematics, Science, and Engineering) majors.

The University of Pretoria states that capability in Mathematics can be improved through academic support that links the progress of mathematical and non-mathematical abilities. This is evident in the research by Steyn and Du Plessis (2007:881). The performance of at-risk students, who were part of the research, and who obtained developmental support, related positively to that of students who were on the regular study programme in Engineering. These students' academic performance in Mathematics improved over the first two years (Steyn & Du Plessis, 2007:889).

2.5.1.5 Class preparation and class revision

For many students who take Mathematics at tertiary level preparing for Mathematics classes and then doing revision afterwards of the work done in class on a regular basis is not possible. Reading course materials in preparation for class and discussing ideas outside the class is done by students who are in the passing grade group, and students who are more likely to be in the non-passing grade group prepare for class by studying notes (Benford & Gess-Newsome, 2006:106). There is a weak connection between the number of hours devoted to class revision and the level of performance in the specific module. Those students spending one to three additional hours per week on their Mathematics module are more likely to pass the module than the students spending no or less additional hours per week on their Mathematics (Benford & Gess-Newsome, 2006:109).

2.5.1.6 Class participation

Another academic factor, which influences students' Mathematics performance, is class participation. Self-explained stages of class participation differ between ethnic groups and between genders (Benford & Gess-Newsome, 2006:108). Females' participation is less than the participation of males and Native Americans participate less than students from other ethnic groups (Benford & Gess-Newsome, 2006:108).

2.5.2 Social factors

The outside responsibilities of students, according to Benford and Gess-Newsome (2006:109-110) are the only social factor the researcher found in the literature, which has the most influence on the Mathematics performance of students. Two non-academic factors, which have an influence on academic performance in Introductory Business, Mathematics and Science modules at the Northern Arizona University, America, are work/finances and motivation and these non-academic factors probably influence females more than males. Work or the students' financial situation probably influences Asian Americans and Hispanics more than other ethnicities. Benford and Gess-Newsome (2006:109-110) also found that family responsibilities probably influence Native Americans more and that African Americans are possibly influenced by taking part in athletics.[1]

2.5.3 Biographical factors

The profile, consisting of many elements, of typical Mathematics students definitely has a major influence on the Mathematics performance of students. These various elements are subsequently discussed.

2.5.3.1 Gender and race

The difference in gender is influenced by the subject content and the reasoning level of the test questions. This fact is concluded by Ubuz (2011:8) from his research that gender is a factor in the students' performance when Riemann sums were asked. The male students performed better than the female students in the questions about Riemann sums and Riemann sum integrals. An explanation for this can be that the exercises on Riemann sums enriched the male students' competence to value and understand Riemann sums exceptionally.

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[1] An extensive search on social factors influencing the Mathematics performance of students at tertiary level in South-Africa yielded not results. The keywords used were: student engagement; social factors; mathematics; South-Africa; performance; tertiary level.

However, from studies done by Eng *et al*. (2010:140) and Alfan and Othman (2005:340) it was found that the female students performed better than the male students in all the underachieved Mathematics courses, which is contradictory to Ubuz's research. Moreno and Muller (1999:41) also emphasise this in their research: African American, Latinos, and women received notably better Calculus I marks than their European American and male peers.

In the replies to the "performance" questionnaire from Anthony's (2000:9) research, no statistically meaningful differences were observed between students' gender. In the replies to the "failure" questionnaire, only two differences were noted. The female students positioned "the influence of boring lecture presentations" as less significant than the male students while the males positioned "assignment completion as a reason for failure" as less significant than the females.

Benford and Gess-Newsome (2006:100) found in their research at Northern Arizona University in America that White/Caucasian students are more likely to be in the groups of students with passing grades, whereas Native American and Hispanic students are probably more represented in the group with non-passing grades (Benford & Gess-Newsome, 2006:102).

2.5.3.2 Language skills

Because of the multilingualism in South Africa with its 11 official languages, it is important to research the influence of the language skills of students in higher education on the Mathematics performances. Afrikaans and English are the two languages, which will be discussed.

Gerber *et al*. (2005:17) researched the influence of second language teaching on undergraduate Mathematics performance. They found that there was a statistically noteworthy variance in the performance of the Afrikaans-speaking students attending classes with Afrikaans as teaching language and Afrikaans-speaking students attending classes with English as teaching language. The Afrikaans-speaking students attending Afrikaans lectures performed better than the Afrikaans-speaking students attending English lectures. The conclusion is that bilingualism is not adequate to guarantee performance in Mathematics.

2.5.4 Self-regulation

Self-regulation is the self-directive process by which students transform their mental abilities into academic skills. Murray (2013:157) indicates in her study that there is a positive but weak relationship between academic self-regulation and the performance of the students. The relationship can imply that self-regulation does not elucidate much regarding the unpredictability of a first-year Mathematics module's performance and that other factors can be liable.

2.5.4.1 Motivation

Being motivated and staying motivated for an apparently difficult module, such as Mathematics can have a significant impact on the students' performance in that module. The literature confirms this statement. Shearman *et al*. (2012:2) found that not just motivation appears to be enough for first-year Mathematics students to do Mathematics or to succeed in Mathematics. The research of Anthony (2000:9) concludes that motivation is the most powerful factor identified by both students and lecturers in the questionnaire concerning the levels of students' performance. The responses from the interviews indicate that motivation is principally focused towards performance aims of completing assignments and examination performance.

2.5.4.2 Self-beliefs

The students' beliefs in the importance of Mathematics and their beliefs in their mathematical abilities have an influence on their performance as was established from the literature. Self-beliefs notably and subtly influence student performance through previous learning, and also openly influenced previous knowledge test performance at the beginning of the subject. The way in which the students make use of their prior knowledge may be influenced by students' self-beliefs. Their all-inclusive learning procedure can be influenced by how the students use their previous knowledge as a foundation for learning (Hailikari *et al*., 2008:68). Students with high ability in Mathematics, have mathematical beliefs, which are considerably different from those students with low ability in Mathematics. This difference also indicates that high-ability students have better Mathematics beliefs in comparison with the low-ability students in the study by Suthar *et al*. (2010:530).

2.5.4.3 Time management

According to Cook and Leckey (1999:167), time management (which is only one of the aspects of student engagement) has been a problem for many students. The majority of the students who completed the "failure" questionnaire in Anthony's (2000:8) research spend four hours or less per week on studying Mathematics and completing assignments on their own. This research also indicates that less than a fifth of the students completed the suggested 12-13 hours of study on Mathematics per week. Crisp *et al.*'s (2009:18) research found that 69% of the students expect to spend at least 11 hours studying independently per week while 39% of the students expect to spend more than 16 hours per week studying privately. Jutila (2004) (cited by Kolari *et al.*, 2006:501) found in her studies, that students spent only 23-25 hours per week studying, which is less than the prescribed 40 hours per week. These students spent on average 23.1 hours per week studying, which includes both contact teaching and independent studying. Chickering and Gamson (1987:4) stated that "Time plus energy equals learning". Students must learn to use their time well and they need help in learning about effective time management.

2.5.4.4 Self-efficacy

Self-efficacy is one's belief in one's ability to succeed in specific situations or to accomplish a task. One's sense of self-efficacy can play a major role in how one approaches goals, tasks, and challenges. The major hypotheses of Hachett and Betz's (1989:263) study: "Self-efficacy with regard to specific Mathematics problems will be related to actual performance on an equivalent set of problems", was not as positive as they had hoped for with a total correlation coefficient of 0.44 between self-efficacy and performance, which signifies a reasonably strong positive link. The students' Mathematics self-efficacy and their performance in a first-year Mathematics module indicate a moderate but positive relationship between them in a study done by Murray (2013:157), although self-efficacy is not a statistically noteworthy predictor of performance in this first-year Mathematics module.

Students' confidence in Mathematics, which is part of self-efficacy, plays a significant role in the good or poor performance of students in Mathematics. Parsons *et al.* (2009:55) define three fields of confidence: *Overall Confidence in Mathematics, Topic Confidence,* and *Application Confidence.* They go further and divide *Overall Confidence in Mathematics* in to three sub-parts, namely *Confidence in Mathematics, Confidence in Statistics* and *Confidence in Life.* The research of Parsons *et al.* (2009:65) concluded that there are relationships between the students' entry prerequisites, the students' *Confidence in Mathematics* and their performance in the university Engineering Mathematics. Most of the students said that their confidence in their competence in Mathematics grew during the year because of their performance in Mathematics, great examination marks, small classes, support in Mathematics, etc. The low GCSE (General Certificate of Secondary Education) marks of students, according to Parsons *et al.* (2009:65), are usually associated with students with the least confidence and students who are not performing in Mathematics.

2.5.4.5 Learning styles

The term learning style indicates the notion that individuals vary with regard to what method of instruction or learning is most efficient for them (Pashler, Daniel, Rohrer, and Bork, 2008) (cited by Murray, 2013:154). The correlation between the learning styles of students and their performance is moderate, but positive according to Murray's (2013:158) research. This indicates that the more the teaching styles accommodate the students' various learning styles, the more enhanced the performance in a first-year Mathematics module will be.

2.5.4.6 Anxiety

Mathematics anxiety is one's destructive emotional response to circumstances which include math, numbers, and Mathematics sums (Ashcraft & Moore, 2009:197). According to Mji and Mwambakana (2008:25) and Pourmoslemi *et al*. (2013:1, 4), there is a statistically meaningful but negative correlation between the Mathematics performance of undergraduate students and their Mathematics anxiety. Their findings indicate that the higher the anxiety for Mathematics, the lower the students'

Mathematics performance. However, Josiah and Adejoke (2014:476) found that the degree of anxiety did not have an influence on the Algebra performance in their study. Those students with an average level of anxiety, however, did the best of all the students. They concluded from the results that an adequate amount of anxiety may, in fact, make performance easy.

2.6 Student engagement influencing student performance

The performance of students is a complex issue and their capacity to perform well depends greatly on their learning and personal development. These aspects are, however, closely linked to student engagement. "Student engagement is generally considered to be among the better predictors of learning and personal development" (Carini *et al*., 2006:2). This principle is deceitfully straightforward: The more the students do extra studying or practice as much as possible in a module, the more they have a tendency to learn about it. Similarly, the more students get feedback from their lecturers on their exploring, problem solving, or preparation, the more skill they are able to develop (Kuh, 2003:25).

Figure 6 illustrates the diverse and multiple facets that have an impact on student engagement according to the NSSE (2015):

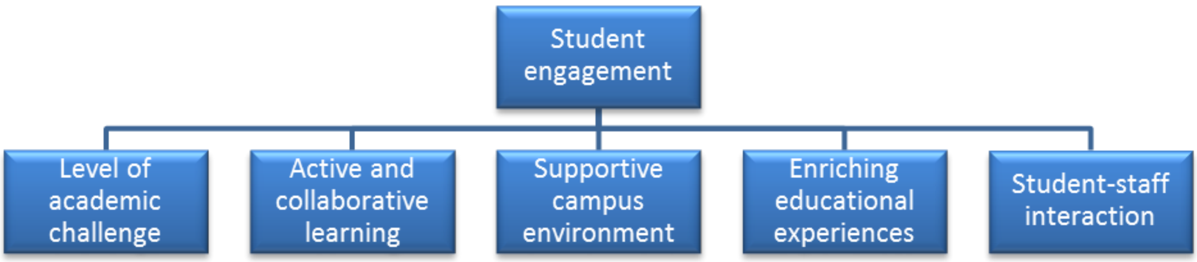

Figure 6: Facets of student engagement

Gunuc (2014:223) found a meaningful relationship between the total score of student engagement and the academic performance score. There was also a meaningful relationship between the sub-factors of student engagement, such as sense of belonging, cognitive engagement (investment in learning, give value to learning,

learning aims, self-regulation, and preparation) and behavioural engagement (students' involvement in academics, their class attendance and involvement and their determination). Overall, Gunuc (2014:224-225), Svanum and Bigatti (2009:128) and Salamonson *et al*. (2009:128) concluded that students with high student engagement scores had high academic performances and those students who had low student engagement scores had low academic performances. According to Baron and Corbin (2012:766), there was a noteworthy correlation between academic engagement and social engagement and they also observed that students perform well when they have a sense of belonging to their institution.

Furthermore, students with a substantial academic orientation indicated a better academic application and more profound learning methods. Horstmanshof and Zimitat (2007:714-715) investigated the connection between two dimensions of student engagement, such as academic orientation (alliance with the wide targets of university education) and academic application (a meticulous attitude to study). They found that there were noteworthy interconnectedness and mutual defining relationships between these two dimensions. The results implied that academic application, academic orientation, and learning styles are reciprocally strengthening features of engagement.

2.6.1 Level of academic challenge

The degree of student engagement is substantially determined by the level of academic challenge. Kuh (2009:16-17) states: "Challenging intellectual and creative work is central to student learning and collegiate quality. Colleges and universities promote high levels of student performance by emphasizing the importance of academic effort and setting high expectations for student performance." These include aspects, such as preparation time, the number of reading texts and written papers, course work emphasising analyses, synthesis, critical thinking and application of theories as indicators of academic challenge. LaNasa *et al*. (2007:957) also found a noteworthy relationship between learning approaches, or homework accentuating analytical thinking, application abilities, and increased student performance.

Perseverance is a further important indicator of academic challenge. Laird *et al*. (2008:90) researched the effect of student engagement between institutions with better-than-expected perseverance ratios and institutions with as-expected perseverance ratios in America. They found that the level of academic challenge stated by first-year students was on average higher at institutions with better-than-expected perseverance ratios than at institutions with as-expected perseverance ratios. These outcomes proposed that in comparison with their equals at institutions with as-expected perseverance ratios, first-year students stated doing more academic work and some of their modules accentuate more difficult levels of reasoning at institutions, which have higher-than-expected perseverance. In this regard, Kuh (2009:17) also links perseverance with academic challenge where students realise that "working harder than you thought you could to meet an instructor's (lecturer's) standards or expectations". However, although McClenney *et al*. (2012:4) found a strong and noteworthy correlation between academic challenge and academic methods, there was rather little indication of a connection between academic challenge and perseverance methods. The expectations set by a higher institution can have an influence on time expectations for students and faculty/staff members, and can determine the foundation for good performance (Chickering & Gamson, 1987:4-5). Envisaging students to do well becomes a self-satisfying prediction when lecturers and institutions have high expectations of themselves and then make additional attempts for students to perform.

Sheard *et al*. (2010:9) view academic challenge as cognitive engagement which includes participation in learning, motivation to learn, eagerness to apply effort to learning challenging ideas and abilities, and the use of approaches. They also state that many lecturers voiced their uneasiness about their students' lack of noticeable motivation to be determined to do their academic work. In the students' survey, they indicated an inclination towards small cooperative classes rather than lectures or functioning with no lecturer in the class. According to Umbach and Wawrzynski (2005:166-167), the mediocre level of academic challenge by lecturers was confidently correlated to first-year student involvements with active and collaborative learning. Furthermore, first-year students were more likely to co-operate with lecturers on campuses where those lecturers present significant academic challenges. There was a definite relationship between student improvements and the level of academic challenges faculties presented on campus. The level of academic challenge for the first-year students was significantly correlated to improvements in overall education knowledge and applied abilities.

Kuh (2003:26) found that “student engagement differs more *within* a given school (or institutional type) than *between* schools (or institutional types)”. The academic challenge facet is illustrated by Kuh (2006:238) with results of seniors at 15 diverse public universities. These institutions ranged from the lowest-achieving school to the highest achieving. He found that the disparity within each institution is much more than between institutions. This also begs the question how academic challenge differs within private institutions on the one hand and public universities and colleges on the other hand where a difference in class size is apparent. The literature is not clear about this. Students at private institutions were largely more engaged in efficient educational procedures than their counterparts at public universities and colleges (Kuh, 2003:26). In part, private institutions are privileged because of their normally smaller size and residential emphasis. Thus, the class sizes are smaller and students relate more regularly with faculty members and fellow students and naturally are more drawn in to the institution’s life. Nevertheless, even though smaller size institutions are usually better in terms of student engagement, the highest-achieving public institutions are as engaging as various small private institutions.

One factor that is closely related to the academic challenge of students, and which is substantially emphasised in the scholarly literature, is time spent studying. It seems as if there is definite correlation between time spent on academic activities and the level of both dedication to academic work (Kolari *et al*., 2008:487, Pace, 1990:102-107; Sheard *et al*., 2010:8;) and motivation (Gasiewski *et al*., 2012:241,243; Kuh, 2007:4,6) to perform well, as illustrated in Figure 7, which was compiled by the researcher. Various statistics are available with regard to the amount of hours students spent per week studying. In general, 20 hours or less per week is considered little time as opposed to 30 hours or more per week, which is considered a great deal of time.

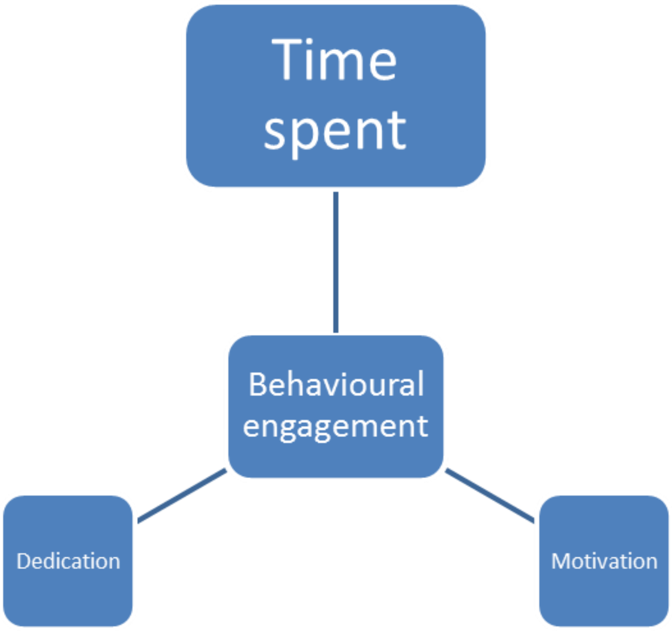

Figure 7: The relationship between both dedication and motivation (behavioural engagement)

However, the literature is not clear about the relationship between time spent on academic activities and the performance of students. Krause *et al*. (2005:33) concluded that there was a contrariwise relationship between the number of hours the students spend in class and their self-described academic performance, with low-performing students normally spending more time in class than the high-performing students. Kolari *et al*. (2008:492) found no significant relationship between time spent on studying and the marks the students obtained and concluded that supplementary to the many disparities in student time spent on studying, there also had to be other effecting factors, such as prior knowledge, learning styles and approaches. Salamonson *et al*. (2009:128) also found that time spent on studying was not the only predictor of academic performance. Conversely, Pace (1990:107) and Kuh *et al*. (2006:17,18) indicate that students who studied more hours per week reflected a convincing influence on their marks, e.g. the majority of students who achieved mostly A's spent 40 hours or more per week on academic activities and the minimum number of students with C-grades, and lower, 40 hours or more.

Chickering and Gamson (1987:4) found that there was no alternative for time on task. It is important for students to learn how to manage their time efficiently. Therefore, assigning sensible amounts of time means efficient learning for students and efficient teaching for faculty. Learning through the acquisition of skills necessitates that students spend sufficient amounts of time on learning. This is particularly important in the context of Mathematics and this will be discussed in the following section.

2.6.2 Active and collaborative learning

Active and collaborative learning is an aspect of student engagement and appears to have a great influence on student performance. Asking questions, making class presentations, collaborating with other students on projects during and outside of class, tutoring other students, participating in community projects and discussing readings and classes with others are all considered actions of active and collaborative learning (Kuh, 2009:17). These actions seem to heighten the intensity of student engagement and consequently student performance.

> *Students learn more when they are intensely involved in their education and asked to think about what they are learning in different settings. Collaborating with others in solving problems or mastering difficult material prepares students for the messy, unscripted problems they will encounter daily during and after college (Kuh, 2009:17).*

Kuh *et al*. (1997:446) and McClenney *et al*. (2012:4) agreed that active and collaborative learning were the most reliable predictor of student performance. Their research indicates that the best predictors of academic improvements for both men and women at three categories of institutions (where the highest degree permitted is the baccalaureate, the master’s or the doctorate) were active learning and support among students. The effect of active and collaborative learning was also persistent in the university experience where a correlation between active and collaborative learning and higher marks, module performance instruments and long-term perseverance and finishing a degree was found.

There is a definite link between collaborative learning and perseverance as discussed above in terms of academic challenge. Research done by Laird *et al*. (2008:91) on active and collaborative learning indicated that first-year students at institutions with better-than-expected perseverance were more enthusiastically contributing in class and had done extra collaborative academic work with their fellow students than the students at institutions with as-expected perseverance.

According to Kember *et al*. (2001:340), learning in an active and collaborative manner appears to give assurance to students to take part as a result of a sense of belonging, and through secure social interactions. Furthermore, taking pleasure in the learning encounter gave elevation to more engagement. Similarly, Umbach and Wawrzynski (2005:165) found a noteworthy correlation between college milieu where lecturers used active and collaborative learning methods and student improvements. Better improvements were stated by first-year students in individual societal progress, overall education expertise, and applied capabilities on campuses where lecturers engaged the students using active and collaborative learning practices.

These collaborative practices are discussed below:

2.6.2.1 Class discussions and presentations

In this context, active and collaborative learning also implies the value of class attendance. According to an Australian study by Crisp *et al*. (2009:16), the majority of the respondents said that attending most classes was important to them. Studies indicate that an engaging class environment bears significant value. Gasiewski *et al*. (2012:246) found in their quantitative research that students who defined their module as mainly lecture-based were probably less engaged in a specific module. These students frequently felt disengaged and apathetic about the module. Contrary to this, the qualitative evaluations of their research discovered that a larger amount of time dedicated to class discussions or group work appeared to improve the regularity of students engaging with subject matters and relating with lecturers inside or outside the class. Thus, active learning, one of Chickering and Gamson’s (1987:4) principles of good practice, is fortified in classes that used well-thought-out exercises, stimulating discussions and peer evaluations.

Krause *et al*. (2005:37) emphasised a key factor influencing students' learning engagement with academics and their fellow students. That factor is the development of an environment in which students can engage enthusiastically and foster a sense of belonging to large and small group surroundings. They found that just over a third of the first-year students indicated they engaged in class discussions or asked questions on a regular basis. However, the majority of students engaged on an irregular basis or not at all. In addition, making class presentations did not appear to be a momentous activity for the majority of the first-year students. Although only a third of the students indicated their regular engagement in class discussions, there had been a continual escalation over the past decade in students' contentment in class engagement in this specific way (Krause *et al*., 2005:38).

2.6.2.2 Collaborating with other students on projects during and outside of class

One of Chickering and Gamson's (1987:3) seven principles of good practice is "develops reciprocity and cooperation among students". This principle connects well with active and collaborative learning. According to them, learning is improved when it is a team effort rather than a single battle. Beneficial learning is collaborative and societal, not secluded and also not driven. Working frequently with classmates enhances learning engagement. Communicating one's personal thoughts and replying to other students' feedbacks refines thinking and excavates understanding.

Active learning can also take place outside the classroom (Chickering & Gamson, 1987:4). Of the students who participated in Krause *et al*.'s (2005:39) research, two-thirds said they studied with their fellow students in one way or another and engaged with them inside and outside of class on assignments and projects.

2.6.2.3 Tutoring other students

Getting academic help from fellow or senior students can be an effective way for students to engage with their studies and thus to perform better. The findings of Gasiewski *et al*. (2012:245) implied that students spending more time with tutors, either off-campus or on-campus at specific locations had a tendency to be more engaged than their fellow students who attended tutoring less often. Bangor University in the United Kingdom has a university-wide Peer Guiding Programme where second- and third-year students proposed support to first-year students in all faculties. Peer Guides kept a devoted connection with their group via singular meetings or small groups throughout and after the transitional period of the first-years (Thomas, 2012:29). Some of the tasks of the Peer Guides are: encourage social integration, aid involvement in Students' Union events, attend to and/or assist with introduction sessions and library visits, arrange/attend a series of social events, assist with module choices, registration and information meetings, etc. Therefore, when first-year students need extra assistance, Peer Guides offer encouragement and aid instantaneous contact with specialised support services.

2.6.3 Supportive campus environment

A supportive campus environment is another important aspect of student engagement, which has positive influences on the performance of students. However, this aspect is the least straightforwardly related to classroom practice (Laird *et al*., 2008:92) as seen from the description given by Kuh (2009:18) of supportive campus environment: "Students perform better and are more satisfied at colleges that are committed to their performance and cultivate positive working and social relations among different groups on campus." This includes providing support to perform academically, to manage their non-academic responsibilities and their need to prosper socially and finally have quality relationships on campus.

Laird *et al.* (2008:92) found that the average institution with an as-expected perseverance ratio recorded lower on supportive campus environment than the average institution with a better-than-expected perseverance ratio. The result therefore indicated that first-year students at institutions with better-than-expected perseverance ratios felt that they received additional social and academic support in comparison with that of their peers at tertiary institutions with as-expected perseverance ratios. Views on the campus environment had meaningful influences on academic improvements for all three types of institution (see 2.5.2), which Kuh *et al*. (1997:446) defined in their research. The individual-societal environment also had a meaningful, but decreased influence throughout the three types of institution.

Matthews *et al*. (2011:115) explored the role of social learning spaces (SLS) in the students' university experience using student engagement to enhance their academic performance. They found that SLS can promote social collaboration between students, which can lead to better engagement in active and collaborative learning (see 2.6.2) and that enables the distribution of knowledge to meet academic challenges. This study also discovered that SLS can assist to advance a sense of belonging and cooperation among students, proposing an encouraging campus environment and overall fulfilment.

2.6.3.1 Providing the support needed to help students to perform academically

The availability of high-value academic support is one of the supplementary important factors efficient institutions employ to help endorse student performance in the first year (Kuh, 2005:92). According to the National Survey of Student Engagement (2001:5), students who received outstanding and decent advice from the institution, were more likely to interrelate with lecturers in several ways and were pleased with their whole involvement with the academic institution. Thus, the outstanding advice was the singular most influential predictor of approval of the campus environment. Krause *et al*. (2005:35) also concluded that, when students notice that the academic support they received was good and that they felt pleased with their choices, they were more likely to dedicate themselves to their studies and be academically engaged. Pike and Kuh (2005:289) go further by observing that the institutional environment was less encouraging for first-generation students in contrast to their counterparts who came from families where at least one of the parents graduated from a tertiary institution. Those students were also less engaged than their peers, and they did not improve much in their learning and academic growth. The supportive campus environment in its totality is summed up by Umbach and Wawrzynski (2005:173) who pointed out that the educational atmosphere formed by lecturers' views, mindsets, and actions had a remarkable influence on student engagement and learning.

2.6.3.2 Providing support to help students prosper socially

Students need not only academic support, but also social support to help them to be engaged and to perform better at the institution. The significance of such social activities was recognised by students (Thomas, 2012:54), and it compelled them to mingle with other students. Organisations and clubs were a valuable way for the students to befriend other students, however, there was barely agreement regarding what extra events the institution should propose. Those students engaged in organisations and clubs were more likely to show a high sense of belonging to the institution, thus, they also acknowledged the inventiveness of the higher institution to establish social interacting groups.

2.6.3.3 The quality of relationships with lecturers, other students, and administrative staff

Specialised services on campus aim to support the student. These services can play an important part for some of the students although most of the students do not make use of these services (Thomas, 2012:61). Thomas found that efficient specialised services have these features:

- students are more liable to engage with academic support and individual improvement obtainable from the institution if they are easily available and if students feel there is a purpose for engagement;
- there is an indication that specialised services are retrieved more if they are located in an academic domain; and
- efficient student support includes good interaction between services.

Supplemental instruction (SI) programmes are an excellent example of support given to students who struggle academically. Harding *et al.* (2011:848) define SI as a "student academic assistance programme that aims to increase student performance and retention". This programme tries to attend to students' needs in an all-inclusive manner. The development of students' skills is the main emphasis and not the transfer of knowledge and thus the important qualities of SI are that it is student-driven, open to all students, voluntary, the emphasis is on high-risk modules rather than high-risk students and it is cost-effective (Harding *et al.*, 2011:849). This programme incorporates study skills with module content and it also inspires peer collaborative learning. The SI-leaders/facilitators are senior students who passed the specific module and who obtained thorough training in the philosophies of non-directive, small group facilitation. The University of KwaZulu-Natal in South Africa also makes use of SI since 2008 (Bengesai, 2011:61). Bengesai's research with chemical engineering students (Bengesai, 2011:59) indicated that SI has the possibility to offer constructive learning spaces for students and to empower them to engage efficiently with learning resources. The students who attended the SI sessions on a regular basis performed well because they were not only taught how to study, but also how to make use of higher-order thinking. The students' confidence was also developed with the help of the SI leaders (Bengesai, 2011:64-65, 67). Students who participated in the research by Eastmond *et al.* (1997:138) at a university in Port Elizabeth, South Africa, reported that the SI programme offered them a calm learning environment, they understood the work better and they spent more time doing exercises. The students realised that they had to come prepared to the SI sessions and change their attitude towards studying. The students also favoured the ambiance of small groups and showed significant progress in their test marks. The advantages of the SI at the university in Port Elizabeth were summarised by Zerger *et al.* (2006:70):

- guaranteeing steadiness during transformation and assisting first-generation students' needs;
- offering financial inducements in terms of prolonged acceptance and throughput policy in reaction to the funding method of the government; and
- enhancing student gratification at the institution with the growth of a sense of belonging and the intensifying of understanding of what it requires to study at a university.

The SI at the North-West University, Potchefstroom Campus offers a non-remedial style of learning improvement that enhances retention and performance (NWU, 2014:71)[2]. Even though SI is mainly used in first-year at-risk modules to provide assistance to the first-year experience of students, SI has been equally successful in second-year and postgraduate modules. At-risk modules are defined as those modules, which are taken by a large group of students (150 and more), which have demanding content and which percentage throughput rate for the specific module is less than 70% (NWU, 2014:72). In 2014, more than 250 SI leaders were appointed to facilitate the majority of at-risk modules of eight faculties on the campus. The influence of SI on students' academic performance was very positive. Those students who attended SI sessions frequently received higher module marks and their drop-out rate was lower than students who did not attend any SI sessions. These results also reveal higher re-enrolment and graduation.

2.6.4 Enriching educational experiences

Students' educational experiences influence their engagement and performance. Kuh *et al*. (2001:3) state that enriching educational experiences make learning more significant and, eventually, more valuable because the students' knowledge becomes a part of who they are. Enriching educational experiences is summarised by Kuh (2009:18) as follows:

> *Complementary learning opportunities in and out of class augment academic programs. Diversity experiences teach students valuable things about themselves and others. Technology facilitates collaboration between peers and instructors. Internships, community service, and senior capstone courses[3] provide opportunities to integrate and apply knowledge.*

Kuh (2009:18) provides an exhaustive list with regard to factors that impact an enriching educational experience of which the following will be explained: participating in co-curricular activities and/or in a learning community, practicum, internship, field experience, volunteer work or community service, foreign language

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2 The annual report of 2015 was not yet available when this study was conducted.

3 Capstone courses are required at university level "so that students begin thinking integratively about their educational experiences". (Weimer, 2013).

course work, studying abroad, and the use of electronic technology to discuss or finish an assignment.

2.6.4.1 Participating in learning communities, or some other formal programmes

Learning communities seem to have an imperative influence on students' engagement with learning, as confirmed by Barefoot (2000:15). To increase student-to-student interaction, she reported on the use of learning communities by universities and/or colleges. These institutions use learning communities to change the key configuration of curriculums to achieve more student-to-student interaction and many extra assured outcomes, such as enhanced retention and average marks of students. Learning communities can be two or more modules connected throughout curriculums so that the same cluster of students enrols in each of the modules. Those students who are part of a learning community experience better social relation and, if the modules are theoretically connected, the students are less destructed than their fellow students who are not part of a learning community. Sometimes, learning communities are connected within residences so that student buddies live in the same room or on the same floor.

Learning communities also have an important effect on students' performance. According to Zhao and Kuh (2004:124), the experience of first-year students with learning communities was related to higher levels of academic determination and incorporation and also active and collaborative learning. They also found that students who had experiences with learning communities were considerably more engaged throughout the range in other academically efficient activities in comparison with their peers who were not involved in such communities. Likewise, learning communities were confidently connected with more regular contact with lecturers, engagement in variety-associated events, and organising classes that highlight higher-order thinking competences. Those students who attended learning communities were also more optimistic about the value of the academic guidance they received and the extent to which the campus was helpful regarding their social and academic requirements. Kuh (2007:7) goes further and confirms that those students who were part of learning communities worked together more with staff members and various peers, they engaged more regularly in higher-order conceptual activities, such as integrating material and evaluating problems, and they also studied more.

2.6.4.2 Use of electronic technology to deliberate on or finish assignments

Presently, students use electronic technology very effectively to enhance their engagement with their studies. Some of the qualitative findings of Gasiewski *et al*. (2012:246) confirm and emphasise the use of electronic technology to enhance students' engagement. Two of the interviewees said that using clickers in class and visiting different web sites to look at videos and complete quizzes on-line, made them more engaged. Krause *et al.* (2005:42) reported that the use of module web-based resources by students, on a daily or weekly basis, improved considerably. A majority of students used these assistance tools at some point during their first year and most of them engaged in the daily or weekly use thereof. In contrast, the use of e-mail to communicate with fellow students or lecturers on a weekly or daily basis was significantly lower. The daily or weekly use of on-line discussions was also restricted by the majority of students who indicated that they never contributed in this specific communication method.

Jawitz (2013:137) conducted research on large class sizes at four institutions of higher education in South Africa. He started the "Large Classes Project", which aimed to improve student learning in large-class settings. Using technology is only one of the ways to reach that goal. He suggested that large classes offer distinctive opportunities for providing the excellent learning experiences we desire for our students. By investing in new technologies, such as multimedia presentation technology and learning management systems, i.e. Blackboard, meaningful learning experiences can be provided simultaneously to large numbers of students (Jawitz, 2013.142). Video recording technologies and podcasting give students the opportunity to appraise what happened in class. Interactive learning during lectures can be aided by using mobile response technology, such as clickers.

Mobile technology is also used effectively to enhance teaching and learning at the tertiary level. These technologies can be categorised into four groups:

- mobile devices, for example iPads and smartphones;
- wireless communication networks, for example data bundles, Bluetooth, 3G/data card, Wi-Fi and general packet radio service (GPRS);
- mobile computers, for example laptops; and
- social networks, for example Facebook (Mayisela, 2013:1).

Mobile technology was successfully used by Mayisela (2013:1) in a Computer Science module at a South African university. He found that the students who had access to mobile technology had a heightened chance of retrieving the module material. Student-to-student and student-to-lecturer communications through social networks also improved.

Lecturers and students can also use Learning Management Systems (LMS), web-based systems, which allow them to distribute instructional resources, make announcements, submit and give back assignments, and communicate on-line with each other (Lonn & Teasley, 2009:686). A number of generally recognised LMS are Blackboard ™, SAKAI™, WebCT™ and Moodle™ (Tredoux, 2012:48). Several of the most familiar functionalities used in the abovementioned LMS are: announcements, assignments, chat, drop box, forums, glossary, grades, messages, polls, resources tools, site stats, syllabus, web content, Wiki, test and schedule (Lonn & Teasley, 2009:687; Tredoux, 2012: 50-54). The research by Lonn and Teasley (2009:687) indicated that the use of LMS was most valuable to lecturers and students in the way in which it enhanced lecturers' capability to share material and information to students rather than overall teaching and learning support to students, and for opening communication from the students to the lecturers or between students and their peers.

The unsure consequences of LMS on students' engagement were reported by Coates *et al*. (2005:29). If LMS are having extensive influences on the arrangement of university teaching, the LMS are apparently influencing student engagement. LMS may perhaps have the ability to affect how students engage with their studies and to alter communication, collaboration, and access to learning materials (Coates, 2005:66). Student learning can also be enriched by LMS by presenting access to a variety of interactive resources, by making sure that module contents are more cognitively approachable, by offering pre-set and adaptive forms of evaluation, and by utilising the technology knowledge of students. Coates (2005:67) found that the full-time, campus-based, early-year undergraduate students at an Australian university reported lower levels of on-line than general engagement and that there were only insignificant correlations between students' general and online engagement styles. It therefore seems as if students are linking their face-to-face and computer-generated learning in a variety of manners. According to Coates (2005:68), an analogy of the general and on-line engagement styles of students can reveal how LMS could be used to improve the students' campus-based experiences at institutional level. It can implicate concluding how the LMS can best be used to utilise students' outside-of-class time to improve leaning. LMS can also include upholding more allocated forms of learning by establishing "learning commons" across the campus. One of the true benefits of LMS is the degree to which they enhance the importance with which students engage with their studies.

Regardless of the increasing acknowledgement of the significance of student engagement, little research has been done on how the implementation of LMS as a tool for autonomous resource-based learning is establishing new forms of engagement. One aspect of engagement is the wide-ranging out-of-class relations students have with the university. What the students' views of LMS-facilitated relations with lecturers and peers are is only one of the many unanswered questions. Concerns about students' relations with the LMS themselves are another aspect of engagement. There is a probability that students see LMS only as a universal division of the university's infrastructure instead of as an exclusive tool, which is useful to their learning. Students' motivation for and confidence with learning or their understanding of the importance of what they have learned, may be affected by LMS. In practice, LMS can facilitate students' academic discussions with their peers and lecturers, their managing of their learning, how they record, share and utilise their knowledge or the time the students spend on truly striving to understand certain areas in their modules.

The LMS used by the North-West University (NWU) is called eFundi™, an open source system driven by SAKAI™ (Henrico, 2012:9458 and Tredoux, 2012:81). The fundamental usage of eFundi™ at the NWU is for the purposes of teaching and learning. Both on-campus and distance-learning students make use of eFundi™. Henrico (2012:9458) primarily used eFundi™ for out-of-class activities and to communicate with business management students. Assessment guidelines and activities were also supplied to these students. eFundi™ also managed "an on-line video environment synchronising web-based video application with timeline-based text annotations" (VideoANT), which were used by fourth-year geography student learners in their micro-teaching lessons (Van der Westhuizen & Golightly, 2015:420). The VideoANT was imported into eFundi™ so that the videos were available to the students. These students used eFundi™ to view the videos of their own micro-lessons and comments could be made by other students (Van der Westhuizen & Golightly, 2015:428).

The participants of this study who are on-campus students used eFundi™ extensively and effectively in their first-year Mathematics module as a learning platform. The functionalities inserted in the Mathematics site were: home, announcements, forums, gradebook, messages, polls, resources, site info, and statistics. Any functionality can be added or removed from the site at any time in the course of the module (Tredoux, 2012:81). Resources are mainly used to upload weekly tutorials for students to prepare for the weekly tutorial test. The memorandums are shared after the tests have been written. The gradebook functionality is regularly used to upload the marks of the assessments done by the students during the semester. A class list, extracted from eFundi™ as an Excel spreadsheet, is shared monthly with the students to keep them updated on their marks and they can report any problems to the lecturer on a regular basis. During the semester, each student's accumulated preliminary participation mark is regularly provided to him/her as assessments are completed. The frequent use of eFundi™ is an efficient communicating teaching and learning platform between lecturers and students.

2.6.4.3 Participating in internships/field experiences, community service/volunteer work, foreign/additional language course work and study abroad

Part of the students' enrichment of their educational experiences is participating in various activities to help them learn important features about themselves and others. Pace (1990:110) found that students' know-how of the tertiary education comprises of both academic and non-academic facets. Results of a questionnaire completed by students taking part in his research indicated that students who spent the minimum number of hours on academic activities may possibly spend more hours on non-academic activities, such as athletic and sport activities, participating in clubs and residence activities, and becoming familiar with a diversity of students. Likewise, Umbach and Wawrzynski (2005:168) found that those who spent many hours per week on academic activities may be less engaged in non-academic activities. The significance, which lecturers attached to co-curricular activities that improve learning, seemed to construct an exceptional learning environment. They also found that first-year students were more engaged on campuses where lecturers put a high level of significance on engagement in enriching educational experiences.

2.6.5 Student-staff interaction

The interaction between students and staff members/lecturers plays a fundamental role in students' engagement with their learning. According to the NSSE (2015), interactions with lecturers can be an encouraging inspiration to the cognitive progress, growth, and perseverance of tertiary students. Through their official and unofficial tasks as advisors, mentors, and teachers, lecturers shape academic work, encourage mastery of knowledge and abilities, and assist students in making links between their studies and their future plans. Kuh (2009:18) states the following about student-staff interaction:

> *Students learn first-hand how experts think about and solve practical problems by interacting with faculty members inside and outside the classroom. As a result, their teachers become role models, mentors, and guides for continuous, lifelong learning.*

Kuh (2009:18) identified the following items of student-staff interaction:

- discuss grades or assignments and thoughts from readings and classes with faculty members outside the class;
- talk about career plans with a faculty member or advisor;
- work with faculty members on activities other than course work or on a research project outside class; and
- receive quick feedback from lecturers on academic performance.

On average, the student-staff interaction was marginally higher at institutions with better-than-expected perseverance than at institutions with as-expected perseverance ratios. However, the discrepancy was not statistically significant and this indicates that the level of student-staff interaction is approximately the same for the two institutional groups (Laird *et al*., 2008:92). According to Kuh *et al*. (1997:446), student-staff interaction was reasonably meaningful only for males at master's-permitting institutions. However, Krause *et al*. (2005:36-37) found more than 20 years later that faculty and/or academic staff played an important role in the engagement of students with their learning and study society. There was an increase over the past 10 years in the number of students and specifically first-year students who frequently contacted academic staff for guidance. LaNasa *et al.* (2007:957) go further by stating that academic collaborations and to co-operate with faculty members, considerably and confidently related the students' attempts and the institution's accentuation on studying with student performance.

The main emphasis on many in- and out-of-class first-year approaches was to enhance their engagement in schedules or events arranged by the institution. Many staff members who teach first-year modules and who have confidence in the importance of student engagement are currently incorporating "engagement prerequisites" on module curriculums, developing out-of-class events that have in the past been non-compulsory into standard modules (Barefoot, 2000:16). This illustrates the value that faculty/staff members place on student engagement for students. In this regard, Zepke *et al*. (2010:8) and Zepke (2011:8) found that academic staff and their way of teaching had a greater effect on student engagement than either exterior (non-institutional) influences (family, employment, social, cultural, and personal) or motivation. When students were encouraged by lecturers who developed fascinating learning environments, required high principles, challenges, and were easily available for discussing academic progress, students were more likely to engage (Bryson & Hand) (cited by Zepke *et al*., 2010:12). Thus, lecturers and/or tutors who are passionate and engaged in their teaching are probably regarded as a requirement for student engagement.

According to Umbach and Wawrzynski (2005:165), where lecturers regularly co-operated with students in their modules, first-year students affirmed better advances in their personal and social progress and also in their overall learning knowledge. However, they found that out-of-class collaborations had less of an influence. Where lecturers stated regular module-related collaborations on campus, first-year students were engaged and more challenged in active and collaborative learning actions (Umbach & Wawrzynski, 2005:163).

The scholarly literature indicates that students are not necessarily comfortable with the idea of approaching staff members. According to Thomas (2012:32), many students even found it challenging to speak to academic staff members, although they appreciate being able to make enquiries to staff for explanations, feedback, and direction. It appears that students who feel that they do not have a good rapport with academic staff members are more likely to think about abandoning their studies. Good rapports are built on comfortable connections that acknowledge the students as entities and cherish their inputs.

2.6.5.1 Discuss grades or assignments with lecturers outside the class

The interaction of students with lecturers outside the class has a great impact on students' engagement and also on their performance. Gasiewski *et al*. (2012:249) concluded that students with better communication skills, those who were resourceful and understood how to be inventive with lecturers or tutors, had a high level of engagement in their modules. Many ways in which the engaged students performed this inventiveness in terms of their collaboration with staff members, were illustrated by the researcher's results from the qualitative study. Some students defined their contact with lecturers as easy and effortless as asking questions in class. Other students, however, looked for staff members outside of class, using their inventiveness to be actively engaged in their own studies. Communications after class, through e-mail, and during office hours with the lecturers were the three distinctive ways students pursued. The researchers also found that although many students anticipated faculty/staff members to be responsible for support, inspiration, and freedom for grasping module content, students need to play an effective part in their own learning. The most engaged students are usually those students who take up their own intervention and vigorously look up faculty/staff members.

2.6.5.2 Talk about career plans with lecturer or advisor

The advice lecturers give students about their career plans is a significant part of students' interaction with lecturers. Kuh (2005:95) stated that if students talk once or twice a term with a lecturer about their career plans, lecturers explain assignments or students ask about module requirements, it is satisfactory for most of the students. The lecturers might also necessitate such interactions, but it seems as if not many do. The seven principles of good practice of Chickering and Gamson (1987:3) also emphasise that regular student-staff interaction inside and outside the classroom is the most important factor in students' motivation and engagement. By knowing some lecturers, the students' academic dedication could be improved and students can be invigorated to think about their own beliefs and career plans.

2.6.5.3 Prompt feedback from lecturers on academic performance

Giving prompt feedback is also one of the seven principles of good practice of Chickering and Gamson (1987:4). Students require proper feedback on their academic performance in order to do well, and they also need regular opportunities to achieve in classes and obtain recommendations to make progress. Reflecting on what students have learned, what they still need to know, and self-evaluation are necessary for students at several stages during their tertiary education. Kuh (2007:7) also confirmed that regular and quick feedback about the quality of the students' academic work will assist them in their performance. Students with high self-assurance levels and who probably do not really think about leaving the university earlier than necessary, have a well-defined awareness about prospects and the evaluation method (Thomas, 2012:36-37). Evaluation feedback should be beneficial to students, and they need guidance on how to use the feedback for forthcoming evaluation tasks.

2.6.5.4 Work with lecturers on activities other than course work (committees, orientation, student-life activities) or on a research project outside the class

The opportunity for students to work with lecturers on research projects outside the class can have a significant influence on students' engagement with learning and enhancing their performance as is evident from the existing literature. According to Barefoot (2000:16), undergraduate research programmes at some American universities gave first-year students the opportunity to collaborate on academic research with lecturers. Several inhabited colleges in America offered some students the prospect of living in residences where casual collaboration with local lecturers is part of the usual living milieu. Lecturers were included in an inclusive first-year seminar programme so that students could have the opportunity to co-operate with lecturers in a small group.

2.7 Student engagement influencing the performance of Mathematics students

Similar to the influence of student engagement on the performance of students in general, which is a complex issue (see 2.6), the influence of student engagement on the performance of Mathematics students specifically is also a complex issue. The five aspects of student engagement, as discussed in 2.6, will also be discussed here, but now specifically for Mathematics performance. Although there is extensive literature available on the influence of student engagement on student performance in general, the influence of student engagement on the performance of Mathematics students in particular and also for Mathematics students at a tertiary institution, is not well researched. This study therefore aims to fill this gap in the literature.

2.7.1 Level of academic challenge

As explained in 2.6.1, the issue of time management is relevant in the context of academic challenge. The staff who participated in the study of Shearman *et al*. (2012:5) felt that students spent insufficient time or no time at all on Mathematics outside the classroom. As expected, some students did not know how to begin with a Mathematics problem and would not persevere when they got stuck. Thus, the lecturers used the available time in class and in tutorials to get students to do Mathematics.

There were three major kinds of challenge, which were valuable to the levels of engagement of the students who took a service Mathematics module at an Ireland university (Grehan *et al*., 2015:22). Those challenges were problems with lecturers at the beginning of the first semester, problems with assignments, and with tutorials. These challenges were common to both the groups of students in this study. The first group faced problems with Mathematics during their first year, but did not make excessive use of the available academic support and therefore failed their first-year Mathematics module. The second group also experienced challenges with Mathematics during the first year but made substantial use of the academic support available and passed their first-year Mathematics module (Grehan *et al*., 2015:1). Conclusions from the study were that the first group apparently did not deal with the challenges of their assignment problems productively, i.e. spend enough time on them. On the other hand, the majority of the students from the second group attended the Mathematical Support Centre (MSC) directly after they struggled with assignments early in the first semester (Grehan *et al*., 2015:22) and were thus able to overcome challenges.

The level of prior knowledge in Mathematics seems to impact on the student's ability to overcome the academic challenges he or she faces. Varsavsky (2010:1047-1048) concluded that the Mathematics performance and Mathematics engagement of those students who did not have prior knowledge of Mathematics in their last year in secondary school did not vary significantly from those students who had senior secondary school Mathematics to an intermediary level. Both these groups of students demonstrated similarly poor performance rates in their mathematical techniques module, which they took at university level. Thus, the consequences were that the students who came to university with Mathematics on an intermediate level were just as at-risk for failure as those students who had no prior Mathematics knowledge or only had knowledge of Mathematics on a basic level. However, students who took Mathematics on an advanced level in senior secondary school proved to have higher levels of Mathematics engagement and were expected to carry on with Mathematics studies to the accomplishment of a major in curricula where Mathematics was a choice.

2.7.2 Active and collaborative learning

The literature is clear regarding the advantages of students collaborating with tutors and with their peers outside of the classroom and with reference to Mathematics performance (Patel and Little, 2006; Shearman *et al.,* 2012; Solomon *et al.,* 2010). Extracurricular support is recommended in that it enhances active and collaborative learning among Mathematics students. Shearman *et al*. (2012:3) explain how from time to time peer-guided learning sessions were planned. These sessions were at times led by expert Mathematics support staff and sometimes led by both peers and staff members. They substituted their normal Mathematics-type tutorials, where tutors spent a substantial amount of time speaking to the whole class, with workshop-type tutorials where the tutors turn out to be facilitators who facilitated small classes or work with one person at a time. The classes were enthusiastically supported by the facilitators with their work by aiming their attention on the tasks at hand (Shearman *et al*., 2012:4). The assisted workshop-type tutorials and the attendance of extracurricular support sessions influenced the students' Mathematics engagement. The students were doing more Mathematics, they were inspired to work on suitable problems and there were facilitators to help those who experienced difficulty (Shearman *et al*., 2012:7). The students' performance increased as their Mathematics engagement improved. Although the improvement was small, it was still meaningful. This enhanced awareness of and the use of extracurricular support facilities were, therefore, a noteworthy adjustment and one can see the positive contribution towards active and collaborative learning.

Keynes and Olson (2000:75) reported on the Calculus Initiative (CI) by the Institute of Technology (IT) at the University of Minnesota, America. The key purpose of the CI was to allow the IT undergraduates to improve the learning of calculus and the critical thinking skills essential to apply it in a diversity of engineering and science problems. The CI also tried to inspire active learning and to offer opportunities for students to collaborate with peers to improve their learning, inside and outside the classroom. The teaching of the module significantly included small group activities, both in the lectures and in the workshops. Teaching CI students how to work efficiently in formal groups possibly impacted on the efficiency of their informal group work, because peer collaboration was regarded slightly more beneficial than small group work. This signifies an important outcome that goes beyond the classroom environment.

Conversely, the literature indicates that if a group of students who faced problems with Mathematics during their first year, but did not make excessive use of the available academic support and therefore failed their first-year Mathematics module, they stopped attending lectures and tutorials and did not do their assignments on a regular basis anymore (thus not as engaged in active and collaborative learning) (Grehan *et al*., 2015:22). Re-engagement later was thus problematic for those students because of the accumulative character of the Mathematics they took. In addition, because many lectures are challenging to follow, are at high-speed and permit little, if any, discussion time, and tutorials are uncertain spaces because many students feel exposed when asking questions, functioning casually with their peers outside of timetabled classes is the only chance to talk about their work. Receiving explanations from someone other than their lecturer is one of the advantages (Solomon *et al.*, 2010:427). This can be interpreted as an example of informal tutoring among peers and also active and collaborative learning outside of the classroom.

In contrast, Patel and Little (2006:133,136) concluded that small groups of students and individual students form a relationship without any difficulty with tutors and the peaceful environment inspires the practice of positive learning. The Mathematics tutors observed that even the struggling students reacted well to tutoring. According to the personal experience of the tutors, those students could be helped to change their failing grades to attaining a better mark than their fellow students who did not use the Mathematics support. The pass rate of Mathematics modules is enhanced by Mathematics support to a level above average for those students who normally have no confidence in their mathematical aptitude. The contribution to and influence towards active and collaborative learning due to mathematics support, either by tutors or peers, therefore, cannot be denied and has a positive impact on Mathematics performance.

2.7.3 Supportive campus environment

The literature indicates that student engagement depends heavily on a supportive campus environment in order to enhance academic performance. Gasiewski *et al*. (2012:251) found that engaged students made use of all the accessible resources and learning support, such as tutors, and revision sessions and they frequently worked together with their counterparts, whether in informal or formal learning groups.

Mathematics learning support is part of a multidimensional combination of aids to the improvement, performance and retaining of students in university curricula (MacGillivray, 2009:470). To empower students to recognise their limitations, thorough tools are vital elements of learning support. Solomon *et al.* (2010:430) mentioned that social learning spaces (SLS) are of immense significance to Mathematics students, and thus, SLS have a great supplementary impact on the excellent Mathematics learning support given to individuals. Research shows that these learning spaces provide specialist support to the Mathematics student due to certain characteristics. Although the support centre's biggest advantage is availability of attentive one-to-one support as an instant reply to particular problems, it is also important for students to have a good atmosphere in the centre and the learning milieu, an enhancement in student control, non-existence of time tensions, and the informality of centres (Lawson *et al.*, 2001:22).

Several studies reported on the valuable contributions of Mathematics learning support centres to student engagement and ultimately Mathematics performance (Gordon & Nicholas, 2012; MacGillivray, 2009; Rylands & Shearman 2015; Symonds *et al*., 2008). Mac an Bhaird (2012) includes mentoring schemes as learning support. According to Symonds *et al*. (2008:7), students using a Mathematics Learning Support Centre (MLSC) on a regular basis often attended lectures and tutorial sessions, which were scheduled on their timetable. Thus, they were conscious of any Mathematics difficulties they had and the possible necessity of academic support.

However, some of the students who failed their Mathematics module did not attend the MLSC because they were not aware of their problems with Mathematics (Mac an Bhaird *et al*. (2013:200). It is noteworthy to perceive that the Arts students in the research by Mac an Bhaird *et al.* (2009:5) who took Mathematics as a module, were more likely to visit the MLSC and visited the centre more regularly than the Science students who took Mathematics as a compulsory module. The higher level of centre attendance by the Arts students could indicate that these students are interested in Mathematics. They also concluded that the at-risk students were more likely to go to the MLSC than the students with a sturdier mathematical background, and appeared to spend time in the MLSC to increase the possibility of passing their exam. Only attending the MLSC is not enough for students to increase their Mathematics marks. Students must also be eager to work self-sufficiently although students' confidence is enhanced when students attend the MLSC, according to Mac an Bhaird *et al.* (2009:7). Thus, it inspires the students to work on a regular basis during the year on Mathematics, and this is an additional significant factor when bearing the final marks in mind.

Rylands and Shearman (2015:72) also researched the influence of learning support on the Mathematics performance of students. They found that the strong relationship between the level of support, attendance of tutorials and the use of the Learning Management System[4] of the tertiary institution implied that the quantity of support, which students used was a decent indicator of the level of student engagement. More confirmation for the noteworthy influences of learning support and/or engagement was the 15% variance in passing rates among those students who used the academic support available to them and those who did not make use of the support. This was, however, not statistically meaningful because of the small sample size the researchers used. Another important conclusion from their results was the poor engagement with both face-to-face and on-line learning support available. It is

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[4] A site including tutorial problems, lecture notes, a discussion forum for students, etc. to help students in their studies (Rylands & Shearman, 2015:72)

possible that many students thought that they did not need help initially, believing they would pass the Mathematics module. Rylands and Shearman (2015:73) also concluded that engagement and not just support was similarly important to students. Nevertheless, the use of support is an assessable indication of engagement.

Learning support plays a part in the inclusive structure of mathematical learning. Such support assists students to develop more mathematical fitness to endure and advance in their university curricula (MacGillivray, 2009:471). The significance of how the student situates him/herself in the Mathematics community of practice is concluded from research done by Solomon *et al.* (2010:423). It suggests the significance of recognising the effect of devoted Mathematics support centres on student characteristics and their attitudes towards learning. Overall, support centres present a service to students, which is additional to their standard programme through individual tutorials and classes.

Mac an Bhaird (2012:74, 77-78) started a mentoring scheme for Mathematics students at a university in Ireland. He and the participants met on a one-to-one basis once every fortnight for up to half an hour sessions. The advantages of such a mentoring scheme in terms of student engagement and Mathematics performance can be summarised as follows:

- low level of engagement changes to high level;
- mentoring initiates involvement in Mathematics support centres;
- at-risk students proved fortitude to pass;
- immediately dealt with mathematical problems.

In contrast, it appears that if at-risk students are not mentored, their Mathematics performance is compromised. The results from the research by Gordon and Nicholas (2012:103) indicated that there was a correlation between students' performances in the introductory calculus module and the students' attendance at the MLSC at a university in Australia. The weekly tutorials held at the MLSC had higher hours of attendance and resulted in better marks in the calculus module. The conclusion of these results was a combination of Mathematics student engagement and suitable support is promising for student performance. They also found that at-risk students disengaged in any support offered to them and thus their learning outcomes were mostly unsuccessful.

As discussed in 2.6.3.3, supplemental instruction (SI) is an important system, which offers academic support to students. At a South African university, Harding *et al.* (2011:851) implemented the SI programme specifically for the large Mathematics class sizes in the first-year Mathematics module. There were two groups of students who Harding *et al.* (2011:854) reported on in their research: the first group attended at least three SI sessions and the second group did not attend any sessions. They found, however, that there was no statistically significant difference between the average Grade 12 marks (higher than 81%) for both groups. Thus, the two groups were academically equivalent and it verifies that the SI programme is allegedly not just for the students who struggle with Mathematics, which was also confirmed by Hensen and Shelley (2003:258). Furthermore, the SI programme had a definite influence on the students' Mathematics pass rate. The pass rate of the first group improved significantly more from the first test to the second test than the improvement shown between the two tests for the second group (Harding *et al.*, 2011:855). The conclusion, therefore, is that attendance of the SI sessions could be an indication of increased performance.

2.7.4 Enriching educational experiences

The use of technology, as revealed by recent research, is a factor, which can enrich students' educational experiences, inside and/or outside the classroom. This includes computer-based aids, various lecture-capturing methods, and on-line classrooms.

Kao (2008:1) and Dede (2000:300) emphasise the increasing impact of technology on students and lecturers during the past decade. These technologies are excellent tools to supply module contents to students to increase their learning experiences and also to improve pedagogy. The National Council of Teachers of Mathematics (NCTM) also identified and emphasised the significance of technology in the teaching and learning of Mathematics as one of the six principles of high quality Mathematics education. This "technology principle" affirms that "technology is essential in teaching and learning Mathematics; it influences the Mathematics that is taught and enhances students' learning" (NCTM, 2000:6). Similarly, Tall (2000:216) emphasises the fact that the accessibility of technology is transforming the character of higher mathematical thinking.

A university in New York implemented an asynchronous on-line tool in their Engineering modules, by making recordings of both the classroom lectures and additional materials available via video podcasts, supplementary to their regular lectures. These podcasts can be accessed by the students at any time. The majority of the participants of Kao's (2008:8) research indicated that the podcasts were valuable to them, particularly when they did homework assignments. Thus, they could re-visit the parts of the lectures, which they had missed. The many occurrences of downloads of the podcasts indicated that most of the students made use of them on a regular basis, and therefore engagement levels were high. Students also felt inspired and comfortable to use technology for their learning, and proficient in improving in various learning environments with diverse technologies and tools (Kao, 2008:9).

Graphing calculators and computer labs were two of the key technologies used in the CI (see 2.6.2) reported by Keynes and Olson (2000:75-76). Graphing calculators are used in classes to do some of the homework, and also in examinations. In the first year, computer labs were used mostly for lengthy projects. The results specify that the lab projects had a partial influence on the first-year students, thus, the projects were evaluated as slightly valuable. The participating students appreciated the inclusive role of technology and this appreciation enhanced with time. The value and efficiency of the first-year lab projects were marginal and requires additional analysis.

Software programs can also be used successfully in the teaching and learning of Mathematics. Stols *et al.* (2008:16) identified Geometer's Sketchpad as graphing software, which serves as an influential teaching and learning medium. This program enables lecturers and students to find correlations between graphic and symbolic representations by using a number of algebraic and trigonometric characteristics. Patterns can be discovered and assumptions can also be investigated and tested by creating their own sketches. Geometer's Sketchpad, Cabri and Geogebra were also identified by Roux *et al.* (2015:290-291) as powerful software, which permits students to investigate mathematical concepts in a creative, integrated and interactive style.

Furthermore, technology can be used in creating high-order thinking activities. Berger (2011:112) made use of Mathematical analysis software (MAS), and specifically of Geogebra to design mathematical tasks. MAS is software which the lecturer or student can use to execute mathematical algorithms using his/her own input. Examples of MAS are a Computer Algebra System (CAS), dynamic geometry packages, function graphers, spreadsheets and also hand-held scientific, graphical or CAS calculators. Geogebra is MAS software, which is a free and open source. It has been designed explicitly for the teaching and learning of Mathematics and has dynamic geometry, spreadsheet, and graphing abilities.

Computer Algebra Systems (CAS), such as MATLAB, Maple and *Mathematica* are software, which function as resources for learning Mathematics at tertiary level (Berger & Cretchley, 2005:97). Currently, many textbooks for undergraduate Mathematics enclose exercises for which computational, CAS and graphing technology are necessary. Berger and Cretchley (2005:97) introduced the use of *Mathematica* to first-year Mathematics students at a South African university for graphing and symbolic manipulation purposes. *Mathematica* is an exceptionally considered CAS, which is capable of creating graphs, performing standard calculator functions, and manoeuvreing of symbols. The attitudes of the Mathematics students at this South African university to use computers, and especially *Mathematica*, were comparable to the attitudes of overseas students (Berger, 2007:17; Berger & Cretchley, 2005:104). Another conclusion from their research is that the disadvantaged students (referring to their contact with or previous introduction to a computer) did not, in general, feel intimidated when computers were introduced in the Mathematics module. In fact, it appears as if these students are more grateful for the opportunities offered by the technology as opposed to other students. Berger (2007:17) also found that the majority of the students were able to use *Mathematica* as a means to facilitate algorithmic and calculation tasks, but less were able to utilise it as a means for learning and thinking about original mathematical ideas.

MATLAB, a scientific software program, was used to investigate the role of technology in the learning of Mathematics for a diverse and large first-year Mathematics class at the University of Southern Queensland, Australia (Cretchley *et al.*, 2000:219). The students' acknowledgement of the use of MATLAB as a suitable software package and support for learning was extensive. They also revealed a very positive response to the experience of using MATLAB to assist their Mathematics learning. The fact that the students were not examined on the use of MATLAB (Cretchley *et al.*, 2000:231), dismissed much of the anxiety related to using MATLAB, and thus it boosted their delight in using technology.

Additionally, technology can be integrated effectively to enhance the lecturers' instruction methods in their classes. Stols (2008:38) integrated a tablet PC in his Mathematics lectures. A tablet PC is "a notebook computer which allows the user to operate it with a digital pen instead of a keyboard or mouse" (Stols, 2008:38). Everything usually done on a chalkboard or transparencies and more can now be done on the tablet PC. The tablet PC can also be used for playing a video clip, using Geometer's Sketchpad to draw graphs, make memos for homework using Solution Builder, and using Windows Journal to create class notes and make them available directly after class via Bluetooth or memory stick. The students' experience of the use of technology in class, and specifically, the tablet PC, was very positive.

On the contrary, Jaskyte *et al.* (2009:113) found that students and lecturers reported that the use of technology, inside and outside the classroom, is not important to them. It is a fascinating fact, particularly since the majority of awards given for innovation in teaching accentuate the use of technology in- and outside the classroom.

The conclusion is therefore that technology should be a fundamental component of any Mathematics curriculum and not be included as an afterthought (Roux *et al.*, 2015:303). This finding indicates that at every contact session, computer rooms/laboratories must be easily accessible to students and not merely for one contact session per week. In addition, student engagement can be enhanced by a technologically increased environment via student-centred exploratory activities and the content enrichment of the learning experiences of students (Yushau *et al.*, 2005:19). Finally, the use of interactive, forceful technology leads to a cognitive restructuring (Berger, 2011:121) when the students' collaboration with technology converts their way of reasoning in a qualitative way.

Technology aside, enriching experiences for Mathematics students are also created by learning communities. Here the focus is on students' reasoning growth by working on associating and correlating skills, ideas, concepts, and processes. Furthermore, enriching experiences also refer to social development by assisting interpersonal connections among Mathematics students in academic situations (Froyd, 2008:8).

2.7.5 Student-staff interaction

Thompson (2001:45) found that there was a meaningful direct correlation between the informal student-staff interactions and the students' mathematical achievements at a community college in America. This direct correlation indicates that students who have apparent higher levels of informal interaction with lecturers outside the classroom plainly improve the students' supposed Mathematics achievements and their levels of determination in Mathematics are also high. In addition, the amount of time students spent at part-time work is, according to Thompson (2001:46), inversely correlated to the students' levels of informal student-staff interaction and their determination applied in Mathematics modules. To improve the student-staff interaction levels in Mathematics, lecturers can inspire the students to engage in active learning approaches, i.e. small groups and by applying knowledge from the classroom to their own lives. This also can be very encouraging for the academic self-efficacy and self-reliance of students at tertiary level. Academic growth and achievement can be a further positive result of high levels of student-staff interaction (Thompson, 2001:50).

Student-staff interaction also includes the issue of teaching styles. Jaskyte *et al.* (2009:115) reported that students view student-staff interactions, among other things, as an important part of lecturers' inventive teaching, and thus lecturers must respect the students' opinions about teaching styles, i.e. if feedback by lecturers and student engagement are essential features of innovative teaching to students, lecturers should strive to find new approaches to attend to students' issues.

A further impact of student-staff interaction is the significant influence on learning and determination. Lecturers can be creative in making contact with their students instead of waiting for the undetermined student, who has Mathematics problems, to seek help during the lecturers' office hours. This interaction between students and lecturers can be via means of communication, i.e. e-mail, face-to-face talks, and discussions (Froyd, 2008:14).

The significance of student-staff interaction is rated highly by students according to research, even as class sizes increased. Facets of successful student-staff interactions include (Keynes & Olson, 2000:75)

- personal interaction;
- approaches of senior lecturers towards students;
- complete assistance of students; and
- overall interactions.

The emphasis on feedback to improve Mathematics performance is a significant part of student engagement within the context of student-staff interaction (Froyd, 2008:11). Contradictory to traditional ways in STEM (Science, Technology, Engineering, and Mathematics) modules of the lecturer providing feedback to the student by returning homework assignments and exams, the role of an efficient strategy for formative assessment (i.e. assessment where key purpose is supplying data for enhancement in contrast to evaluation) provided by the lecturer, is stressed in the research by Froyd (2008:11-12). On the other hand, although small groups and an active learning approach frequently offer formative feedback by lecturers to students, it is not clear in the literature whether it is the active learning engagement or the formative feedback that causes enhanced students' performances.

2.8 Summary

In this chapter an in-depth literature overview of student engagement was provided. More than one definition of student engagement was discussed to emphasise the complexity of student engagement. Because of the multi-dimensional nature of student engagement, it was important to discuss the different elements of student engagement identified by numerous researchers. General factors, which influence the performance of students in general, and in Mathematics in particular of students at tertiary institutions, were reviewed. Lastly, the influence of student engagement on the performance of students in general, and then on the Mathematics performance of students, explicitly, were discussed. The researcher’s design and methodology will be discussed in the next chapter.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The research aim of this study is to determine the influence of student engagement on the performance of first-year Mathematics students in their first semester.

In the literature study (Chapter 2), general factors influencing students' performance (see 2.4) and general factors influencing Mathematics performance (see 2.5) were broadly discussed. Also discussed extensively, was the significant influence, which student engagement has on students' performance in general (see 2.6) and students' performance in Mathematics (see 2.7) specifically.

In this chapter, a discussion of the mixed methods approach, which includes both quantitative and qualitative facets of data collection and analysis, is given. In 2014, a pilot study was done by administrating the modified NSSE to ascertain whether the adjusted questions in the questionnaire, specifically for Mathematics students, were correctly formulated. The quantitative part of the research was based on a modified version of The National Survey of Student Engagement (NSSE). The questionnaire was modified to adapt to the South African environment. All 2015 first-year Mathematics students at the Potchefstroom Campus of the North-West University were given this questionnaire to complete. The 304 participants' responses to the questionnaire were supported by six interviews (the qualitative approach of the research) to explore what impelled their responses, i.e. to explore their interpretations in terms of their chosen options for equivalent questions in the questionnaire.

Also discussed in this chapter, is the research design and method used to determine the participants' views on their engagement with Mathematics. The following aspects will be discussed in detail:

- Aim of the research

- Research design
- Population and participants
- Role of the researcher
- Data collection methods
- Data analysis
- Reliability and validity
- Ethics
- Summary

3.2 The aim of the research

The overall aim of this two-phase sequential, mixed methods research study is to determine the influence that student engagement has on the performance of first-year Mathematics students in their first semester at the North-West University, Potchefstroom Campus. Both quantitative and qualitative methods were used to achieve this aim.

The quantitative research was conducted during the first phase. The participants completed a questionnaire to determine their level of student engagement with their first-year Mathematics module. The second phase entailed performing the qualitative research by means of individual, semi-structured interviews to explain the quantitative data further, to enrich the data, and also to get the participants' personal experiences of their engagement with Mathematics.

The main research question that guided this study is: What is the influence of student engagement on the performance of first-year Mathematics students?

3.3 Research design

Research designs are the ideas and the processes for research that cover the choices from wide-ranging conjectures to comprehensive data collection and analysis methods (Creswell, 2009:3,223). They also contain the coming together of philosophical conjectures, inquiry strategies, and particular methods.

Creswell (2009:3) defines mixed methods research as:

> *"... an approach to inquiry that combines or associates both qualitative and quantitative forms. It involves philosophical assumptions, the use of qualitative and quantitative approaches, and the mixing of both approaches in a study."*

Ivankova *et al.* (2007:261-262) go further by defining this research design as the researcher gathering both numeric data, i.e. survey scores or rankings, and transcript data, i.e. observations or open-ended interviews, to get answers to the research questions. Thus, the data or the conclusions are linked or incorporated at one or numerous stages within the study.

Creswell and Clark (2011:69) identify four fundamental mixed methods designs, such as convergent parallel design, explanatory sequential design, exploratory sequential design, and the embedded design. The mixed method design used in this study was the explanatory sequential design. An exemplary version of this design is portrayed in Figure 8:

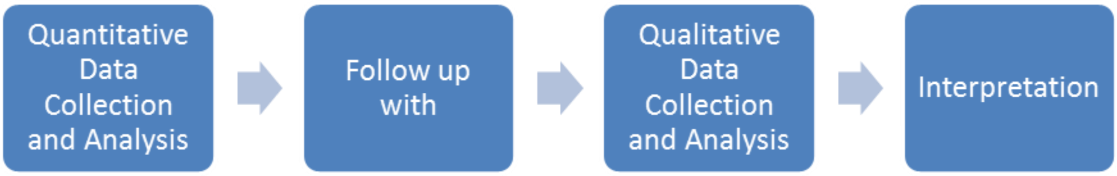

Figure 8: The explanatory sequential design (Creswell & Clark, 2011:69)

The explanatory design transpires in two separate collaborative phases, as shown in Figure 8. This design begins with the collection and analysis of quantitative data, which has the priority for concentrating on the questions of the study (Creswell & Clark, 2011:71). The successive collection and analysis of qualitative data follow the first phase. The second phase of the study is constructed with the purpose of following from the findings of the quantitative phase and Creswell (2008:560) stresses the fact that "a small qualitative component follows in the second phase of the research". This will be explained further in 3.6.2.1 where the participants for qualitative data collection are discussed. According to Ivankova *et al.* (2007:265), the qualitative results from the second phase assist in improving, explaining or elaborating on the quantitative findings from the first phase. The fact that the explanatory design is two distinct phases, which make the implementing forthright, is this design's advantage. Furthermore, the describing and reporting of the explanatory research is thus easy to do.

The researcher has chosen this mixed methods design because the collection and analysis of the quantitative data were the main source from where the findings were interpreted. Thus, the emphasis was on the quantitative data, which were enriched, refined and explained further by the qualitative data.

3.3.1 Philosophical world view

Research is a procedure of phases used to collect and analyse data to enhance our interpretation of a matter or topic. Research entails three phases:

- Ask a question,
- Collect information to respond to the question, and
- Pose an answer to the question (Creswell, 2008:3)

The research paradigm, which the researcher followed, is the pragmatic paradigm. Creswell (2009:6) uses the word "world view" instead of "paradigm". He defines pragmatism as:

> *"Pragmatism is a world view that arises out of actions, situations, and consequences rather than antecedent conditions (as in post-positivism)" (Creswell, 2009:10).*

Pragmatism, according to Creswell and Clark (2011:41), is usually related to mixed methods research. The emphasis is on the effects of research and on the key meaning of the question asked rather than the methods. The use of several data collection methods to advise the problems under study is another focus of pragmatism.

Creswell and Clark (2011:42) go further and summarise elements of the different world views.

- *Ontology* (the nature of reality) – Particular and numerous realities (Researchers review hypotheses and offer several perspectives.)
- *Epistemology* (the relationship between that being researched and the researcher) – Practically (data collection by researchers by "what works" to deal with the research question)
- *Axiology* (the role of values) – Numerous viewpoints (Both biased and unbiased outlooks are included by researchers.)
- *Methodology* (the process of research) – Combining (Both qualitative and quantitative data are collected and mixed by researchers.)
- *Rhetoric* (the language of the research) – Formal or informal (Researchers can use both formal and informal writing styles.)

Being a pragmatic researcher, Onwuegbuzie and Leech (2005:383) mention that such researchers are more prone to endorse collaboration between different researchers, despite philosophical emphasis. Being positive towards qualitative and quantitative research, pragmatic researchers are fortunate to use qualitative research to enlighten the quantitative part of their research, and *vice versa*. Since mixed methodologies within similar reviews are used by pragmatic researchers, they are capable of exploring further into data to be familiar with its meaning and to utilise one method to confirm results from the other method (Onwuegbuzie & Leech, 2005:3 84).

3.3.2 Research strategy

The research strategy the researcher chose was the sequential explanatory mixed methods strategy. This mixed methods process is that in which the researcher pursues to expand or elaborate on the results of one method with an alternative method (Creswell, 2009:14). This can involve commencing a qualitative interview for investigative meanings and followed by a quantitative, survey method with a large sample group, with the purpose that the researcher can generalise the scores to a population. A study, on the other hand, may begin with a quantitative method wherein a concept or theory is verified, followed by a qualitative method implicating comprehensive investigation with a few individuals or cases. As mentioned in 3.2, the researcher first conducted the quantitative research method and followed it up with the qualitative research method.

3.3.3 Research methodology

3.3.3.1 Quantitative research method

Maree and Pietersen (2007a:145) describe quantitative research as a method that is impartial and methodical in its ways of using numeric information from a designated population to generalise the conclusions to the studied population. Theories about realism are tested by the researcher using a quantitative research method. He/she looks for reasons and results and uses quantitative procedures to collect data to assess the questions or hypotheses (Ivankova *et al.*, 2007:255). The researcher also reports the variables to establish the importance and regularity of connections.

Likewise, according to Creswell (2009:4), quantitative research is a way for analysing impartial concepts by investigating the connection among variables. These variables can be assessed, usually on instruments, so that numeric data can be evaluated by using statistical measures.

In this study, quantitative research was used by administrating a questionnaire (adapted from the NSSSE) to collect data about first-year Mathematics students' student engagement and how it influences their performance in Mathematics.

3.3.3.2 Qualitative research method

The ways to investigate and understand the significance individuals or groups assign to a social difficulty is described as qualitative research (Creswell, 2009:4). The research process includes developing questions and measures, usually collecting data in the environment of the participants, inductively constructing data analysis from specifics to universal themes, and analysing the meaning of the data. In general, a researcher aids as a data collection instrument and asks comprehensive, open-ended questions to the participants to permit them to reveal their opinions about and involvements with the experience (Ivankova *et al.*, 2007:257). Researchers record the data by formulating transcripts on observations and/or interviews and by using video and audio recording appliances. For additional analysis, the text data is transcribed.

The researcher in this study made use of semi-structured individual interviews with first-year Mathematics students who also participated in the quantitative part of the research. The interviews' aim was to enrich the data from the quantitative results from the study and to draw better conclusions and make better recommendations.

3.4 Population and participants

3.4.1 Quantitative research

The target population was the 712 first-year Mathematics students who took WISN111 (Algebra and Calculus I) at the Potchefstroom Campus of the North-West University in 2015. They were registered for Engineering, Natural Science, Business Mathematics and Informatics (BMI) and certain Commerce courses. Consent forms (see addendum 4) were given to the target population and 350 of the students gave their consent to take part in the research and completed the questionnaire. Only those students who took first-year Mathematics for the first time in 2015, and who finished grade 12 at a South African school were considered for the study. After these excluding criteria, the data of the study population of 304 students were used, analysed and interpreted.

The profiles of the participants are summarised in Table 1:

Table 1: Profiles of respondents (n=304)

		Number (%) of respondents
Gender	Male	208 (68%)
	Female	96 (32%)
Age	17	3 (1%)
	18	120 (40%)
	19	154 (51%)
	20	10 (3%)
	21	5 (2%)
	22	3 (1%)
	23	1 (0.3%)
	24	4 (1%)
	25	1 (0.3%)
	26	1 (0.3%)
	29	1 (0.3%)
Year in Grade 12	2014	271 (89%)
	2013	17 (6%)
	2012	4 (1%)
	2011	2 (0.7%)
	2010	2(0.7%)
	2009	2 (0.7%)
	2008	3 (1%)
	2006	1 (0.3%)
	2003	1 (0.3%)
Study programme/degree	B.Ing	185 (61%)
	BSc	107 (35%)
	BMI	8 (3%)
	BCom	2(0.5%)
	BA	2 (0.5%)
Type of secondary school	Urban public school	184 (61%)
	Rural public school	49 (16.3%)
	Private school	39 (13%)
	Urban technical school	18 (6%)
	Rural technical school	6 (2%)
	Township school	3 (1%)
	Home schooling	2 (0.7%)

		Number (%) of respondents
Type of residence	Dormitory or other on-campus housing	153 (50%)
	House/apartment within walking distance from campus (not parents' house)	108 (36%)
	House/apartment farther than walking distance from campus (not parents' house)	25 (8%)
	Parents' house	16 (5%)
	Another place of residence	2 (1%)

3.4.2 Qualitative research

After the participants of this study completed the questionnaire at the end of the first semester of 2015, the researcher conducted six individual, semi-structured interviews with individuals who also participated in the quantitative phase of this study, in order to get the interviewee's experiences in the most truthful probable way. The duration of the interviews was between 10 and 20 minutes. The researcher chose two students to interview who were highly successful in their first-year, first semester Mathematics, two students with average marks for their Mathematics and two students who failed their first-year, first semester Mathematics. The interviews were conducted at the beginning of the second semester of 2015. To record the interviews, the researcher made audio recordings of each interview. Each participant, who participated voluntarily, gave permission to the researcher to make a recording of the interviews by completing a consent form (see addendum 4).

3.5 Role of the researcher

The role of researchers is an important instrument, especially in qualitative research (Creswell, 2009:175; Nieuwenhuis, 2007a:79). Researchers gather data themselves through assessing documents, studying behaviour, or interviewing participants. Furthermore, Nieuwenhuis (2007a:79) mentions that researchers' engagement and commitment in the changing of the real-world conditions are important given that it is required from researchers to record those changes. Creswell (2009:177) also views qualitative research as interpretative research with researchers usually involved in a continued and rigorous experience with participants. Researchers openly ascertain their values, prejudices, and personal backgrounds, such as culture, gender, socioeconomic status, and history, and interpretations made by researchers during the study may be formed by these characteristics.

The researcher of this study is a qualified lecturer who has been directly involved with lecturing first-year Mathematics students for the past 13 years. The academic and social challenges, which the first-year students experience on a daily basis are therefore familiar to the researcher because of past experiences as a teacher of Mathematics in secondary schools, which gives the researcher significant insight into the curriculum of Mathematics at school level, and especially the Grade 12 curriculum. Thus, the researcher is also aware of the current challenges Grade 12 learners face to be adequately prepared for the first year at a tertiary institution, particularly in Mathematics, and the existing gap between school and university (Benadé, 2013:21-22, 25; Engelbrecht *et al*., 2010:12). Furthermore, currently being involved with teaching additional classes for Grade 11 Mathematics learners helps the researcher to understand what is being done at school level and the Mathematics knowledge the learners have, or do not have when entering a university (Benadé, 2013:21,26).

The engagement of first-year Mathematics students came to the researcher's attention after realising that the students' module marks did not really improve over the past five years. The average Mathematics marks each year were approximately the same despite efforts by lecturers to improve engagement and to decrease the gap between Grade 12 and first-year Mathematics.

The role of the researcher with regard to the quantitative research was twofold. Firstly, her role in data collection was to administrate the completion of the questionnaire by the participants, and secondly, it was, in collaboration with the Statistical Consultation Services (SCS) of the North-West University, Potchefstroom Campus, to analyse the data.

3.6 Data collection methods

3.6.1 Quantitative research method

3.6.1.1 A questionnaire as quantitative research tool

McMillan and Schumacher (2001:602) (cited by Creswell, 2009:155) give the following definition of a survey design: “the assessment of the current status, opinions, beliefs and attitudes by questionnaires or interviews from a known population”. The researcher, however, only used a questionnaire as the quantitative research tool.

The researcher modified The National Survey of Student Engagement (NSSE), under the guidance of her supervisors, to adapt to the South African environment. The NSSE was created in 1998 in America as a new methodology to collect information about students’ educational value (NSSE, 2001). A successful pilot project in 1999 was guided by the NSSE with funding from The Pew Charitable Trusts. This pilot study engaged more than 75 carefully chosen universities and colleges and was administrated in two parts: a “try out” part in the Spring of 1999, comprising a few institutions, and in the Fall of 1999, a larger pilot trial. The main aims of the combined pilot project were to test the NSSE and related technical points of the administration processes and to inspect the effectiveness of the NSSE to gather data about institution quality as a national methodology. The investigation about the educational experiences of undergraduates was the purpose of the construction of the NSSE. Specific classroom activities and particular lecturer and peer practices were found by the design teams’ research, to be linked to excellent undergraduate student conclusions. The design team also found that the level of engagement of students with their studies explicitly influences the quality of student learning and their all-inclusive experiences at university or college.

The modified questionnaire used in this study consisted of 94 questions (see addendum 1). The researcher added three additional questions to the questionnaire, which emphasise student engagement in a South African context. A 4-point Likert-type scale was used for the majority of the questions. Only closed-ended (structured) questions were part of the questionnaire. Closed-ended questions require responses from the participants to make a choice of one and occasionally more than one response out of a set of responses. Closed-ended questions provide the opportunity for easy analysis of the obtained data in contrast to data, which were obtained from open-ended questions (Creswell, 2008:398; Creswell & Clark, 2011:177; Maree & Pietersen, 2007b:161).

3.6.1.2 Pilot study

Pilot testing the questions of a questionnaire helps the researcher ascertain whether the participants in the sample population are proficient in answering the questionnaire and that the questions are understood correctly by the participants (Creswell, 2008:402). This is a process in which researchers make alterations to the questionnaire according to the feedback received from a small number of participants who completed and assessed the questionnaire. Creswell (2009:150) adds that a pilot study is essential to improve the questions, scales, and layout of the instrument, and to ascertain the content validity of the instrument.

In this study, a pilot study was done by administering the modified National Survey of Student Engagement (NSSE) to ascertain whether the adjusted questions in the questionnaire, specifically for Mathematics students, were correctly formulated. 111 students out of all the students who registered for the first-year Mathematics module in the second semester of 2014 were targeted to take part in the pilot study. Consent forms (see addendum 4) were given to these 111 students who were in one class group (total of six class groups), who were registered for first-year Mathematics during that semester. The same consent form for the quantitative part of the research was used in the pilot and full study. All of the students gave permission to take part in the pilot study. After the statistical analysis was done, the conclusion was that the students took completing the questionnaire seriously because the Cronbach Alpha values were all statistically significant. Based on the feedback from the pilot study, the questions in the questionnaire were modified and formulation improved.

3.6.2 Qualitative research method

3.6.2.1 Interviews as qualitative research tool

An interview is a collaborative discussion between an interviewer (the researcher) and the interviewee (the participant). Questions are asked by the interviewer to the interviewee to collect information and understand the participants' views, beliefs, opinions, ideas and manners (Nieuwenhuis, 2007a:87). The goal of qualitative interviews is

- to observe the world through the eyes of the interviewee; and
- to obtain valuable explanatory information that will help the interviewer understand the interviewee's interpretation of knowledge and societal authenticity.

If the interviewees think the subject matter is valuable and the interviewer can be trusted, the given information will be of such a nature, that it will not be necessary to collect it in another way.

Three types of interview can be identified in qualitative research: open-ended (unstructured), semi-structured, and structured interviews (Nieuwenhuis, 2007a:87). Creswell (2009:181) categorises qualitative interviews as where researchers administrate face-to-face and/or telephone interviews or are involved in focus group interviews with six to eight interviewees per group. These interviews include a few unstructured and usually open-ended questions to provoke interpretations and beliefs from the interviewees.

The researcher made use of individual, semi-structured interviews in this study and therefore only this type of interview will be discussed in detail. Semi-structured interviews are normally used in research studies to verify data developing from other data sources (Nieuwenhuis, 2007a:87). A series of scheduled questions are normally asked for the participants to answer and this gives the opportunity for the elucidation and probing of answers. The route of analysis is mainly defined by the semi-structured interview agendas. Researchers must pay attention to the answers of the participants so that they can recognise new developing routes of analysis that are clearly linked to the subject matter being studied. Many of the questions, which the researcher in this study asked the interviewees, were selected questions from the questionnaire. However, many probing questions were directed at the interviewees, but not all probing questions were asked to all the interviewees. A list of the questions asked in the interviews, is as follows:

Question 48:
How many hours per day did you study for WISN111 in a typical 7-day week?
Question 49:
How many hours per week did you visit the maths centre?
Question 70:
During the first semester, how difficult did you experience the learning of WISN111 material?
Question 71:
During the first semester, how difficult did you experience managing your time for WISN111?
Question 73:
During the first semester, how difficult did you experience getting academic help with your studies?
Question 74:
During the first semester, how difficult did you experience the interacting with the WISN111 lecturers?
Question 56:
During the first semester, how often did you discuss your academic progress with a lecturer?
Question 57:
During the first semester, how often did you approach a lecturer to assist you with WISN111 outside the classroom?
Questions 25:
How would you explain your preparing/revision for the WISN111 class? (Shorter version of question 25 in questionnaire)
Questions 68:

Do you really try hard to get the solution of a sum or do you despair easily? (New interpretation of question 68 in questionnaire)

Questions 69:

Do your try to really understand the work or do you learn to pass and apply the techniques without understanding? (New interpretation of question 69 in questionnaire)

The following questions were also asked to the interviewees in the individual interviews:

- How did you experience the WISN111 module?
- How did you prepare for tests?
- Did you do the homework that was given in the Study Guide?
- Do you feel that it was worthwhile to come to the Mathematics centre?
- Is there any general information about the Mathematics of the first semester that you want to tell me?
- Did you try to spend some time on Mathematics during weekends when you did not have time for it during the week?
- Were you disappointed with your test results in the first semester?
- How long before a test did you learn for the test?
- How did you do in general in the tutorial tests in the first semester?
- How was your work in class? Did you use your time in class to do the tutorial? And did you do the tutorial beforehand or only during the class just before the test?
- How was your transition from Grade 12 to university, and specifically in Mathematics?
- Did you attend the refresher course?
- The work that you have done in the refresher course, did it help you with the Mathematics module material in the first semester?

- If you look back to the first semester, would you have learned harder for the Mathematics? Would you have done it in a different way?
- Where are you staying?
- Did you use the translation in the class?
- Do you have many classes per day?
- What was your mark in Grade 12 for Mathematics?
- What was your mark for Mathematics in the first semester?
- If you had maybe asked for more help in the 1st semester, would your marks maybe look better?
- The amount of effort that you put into Mathematics last semester, does that reflect in your marks for the test or do you feel that you have put in a great deal of time and that did not reflect in your tests?
- Do you study with some of your peers?
- Can you still improve your engagement with your work, do you think?

The recording of an interview must be done accurately. The answers of the interviewee can be written down, but that can be very time consuming and the interviewer can easily be side-tracked. An audio recording should rather be used to record the interview, but the interviewee must give his/her permission for the recording. It can be valuable for the interviewer to take notes so that the answers can be assessed and therefore additional questions can be asked, if necessary (Nieuwenhuis, 2007a:89).

To acquire the maximum amount of information from interviews, and to confirm that what the interviewer has heard is in fact what the interviewee has said and intended, the interviewer can make use of three probing strategies, i.e.

- Detail-oriented probes (understanding the “who”, “where” and “what” of the answer the interviewee has given);
- Elaboration probes (studying the subject matter more intensely), and

- Clarification probes (the answer must be explained in more detail by the interviewee (Creswell, 2008:229 and Nieuwenhuis, 2007a:88-89).

A computer-aided audio recorder was used to record the interviews. The researcher took some notes during the interviews and asked additional questions to some of the interviewees after the predetermined questions were asked. From the three types of probing strategy, the researcher used a combination of the strategies for the six interviews to get additional valuable information from the interviewees.

3.7 Data analysis

Data analysis in mixed methods research entails distinctly analysing the quantitative data and qualitative data (Creswell & Clark, 2011:203). It also entails analysing both sets of data using methods that "mix" the quantitative and qualitative data and outcomes, i.e. the mixed methods analysis. In general, data are analysed to deal with the research questions through diverse steps and through important conclusions made by the researcher.

3.7.1 Quantitative data analysis

In quantitative data analysis, the data are analysed by researchers based on the nature of hypotheses or research questions and the applicable statistical test to address the hypotheses and research questions is used. According to Creswell and Clark (2011:207)

> *"the choice of statistical test to use is based on the type of questions being asked, the number of independent and dependent variables; types of scales used to measure those variable, and whether the variable scores are normally or non-normally distributed".*

Different types of numerical values distributed across a specific collection of values are part of quantitative data (Pietersen & Maree, 2007a:186-189). This distribution of values can be explained in terms of its "location or central tendency, spread or variation, and shape or form". The central tendency of a distribution is described by the mode, median and mean, which are three recognised and generally used measures (see 4.2.3.1).

The data analysis for this study was done by the Statistical Consultation Services (SCS) of the North-West University, Potchefstroom Campus using SAS (SAS Institute Inc., 2015). Descriptive statistics used to describe the data were the frequency, the mean, and the standard deviation. To determine the reliability of constructs in the data set, Cronbach's Alpha coefficients were calculated. All the constructs were formed according to the left side of the item on the questionnaire, which the students encountered, for example: During your last year of high school and first semester at university, approximately how often did you attend the Mathematics class with incomplete homework or assignments? (see addendum 1, question 27). For the dual type of questions, as in the previous example, the Cronbach's Alpha values were calculated for the part of the item which the participants were exposed to first. Confirmatory factor analyses were done to assure construct validity of the constructs in the dataset as well as for data reduction purposes. To ascertain whether a factor analysis is applicable, Kaiser's measure of sample adequacy (MSA) was calculated for each confirmatory factor analysis. Thus, the MSA gives an indication of the inter-correlations among the different variables, and to confirm the appropriateness of the MSAs, the measure can be interpreted with the following guidelines of Hair *et al*. (2014:104):

- ≥ 0.80 (meritorious);
- 0.70 (middling);
- 0.60 (mediocre);
- 0.50 (miserable) and
- < 0.50 (unacceptable).

When researchers want to construct a model with numerous predictors, it is important to select the predictors for the model in a certain way because the regression coefficients' values are influenced by the model's variables. Hence, the chosen predictors and the manner in which they were submitted into the model can have an enormous effect (Field & Miles, 2010:186). Linear regressions were done to determine the most important predictors of the first-year, first semester, Mathematics performance by using the available data. The stepwise selection procedure was used in all the regression model procedures. Analysis of the practical significance of the strength of correlation coefficients, r, was done. To interpret the correlation coefficients, the following guidelines were used:

- $r = |0.1|$ (small effect);
- $r \geq |0.3|$ (medium effect, noticeable with the naked eye)
- $r \geq |0.5|$ (large effect or practical significant) (Cohen, 1988).

The coefficient of determination R^2 was calculated to measure the goodness-of-fit of the regression line through all points of the scatterplot. R^2 is seen as a proportion and thus lies between 0 and 1. The cut-off points of R^2 are:

- < 0.13 (not practical significant);
- 0.13 – 0.25 (significant)
- > 0.25 (practical significant) (Steyn & Swanepoel, 2007: 17-18).

As a result of the fact that no random sampling was performed, no inferential statistics were done. Thus, the interpretation of comparisons between construct means was done according to Cohen's effect sizes, d (Cohen, 1988). According to Creswell (2009:167), an effect size recognises the intensity of the deductions about group variances or the correlations between variables. Hence, Pietersen and Maree (2007b:211) defines an effect size as a uniform, scale-free measure of the extent of the difference or relationship being tested, and it is not influenced by the sample or population size. The effect size is calculated as the proportion of the variation accounted for by the regression line relative to the proportion not accounted for $f^2 = \frac{R^2}{1-R^2}$ (Swanepoel *et al.*, 2010:308).

To make conclusions from the effect sizes, the following guidelines were used:

- Effect sizes smaller than 0.15 give a small effect.
- Effect sizes between 0.15 and 0.35, give a medium effect.
- Effect sizes greater than 0.35 give a large effect.

3.7.2 Qualitative data analysis

For a better understanding of and to expand on the quantitative data, qualitative data was also collected.

The procedure of data analysis comprises making sense of the written text and/or image data. Preparing the data for analysis, leading diverse analyses, understanding the data better and better, representing the data, and interpreting the larger significance of the data, are all included in the data analysis procedure (Creswell, 2009:183).

Figure 9 illustrates the steps which can be followed in the analysis of data in qualitative research.

Figure 9: Data Analysis in Qualitative Research (Adapted from Creswell, 2009:185)

The data analysis procedure is explained further in the following descriptions (Creswell, 2009:185-189):

- *Organise and prepare* the data for analysis. This includes transcribing the interviews, typing of field notes, etc. If the data were collected by means of an electronic device, the data must be transcribed verbatim (i.e. written down word for word) and preferably by the researchers themselves, as the researchers will almost certainly incorporate some non-verbal prompts in the transcript (Nieuwenhuis 2007b:104). Thus, in this study the researcher transcribed the six individual interviews verbatim by listening to each audio recording, to manage the bias of the researcher.
- *Reading through all the data*. An overall sense of the information must be attained and contemplated on the general meaning of the data. The researcher read through the transcribed interviews several times to get a better understanding of the content of each interview.
- Use a *coding process* for a meticulous analysis of the data. Nieuwenhuis (2007b:105) defines coding as evaluating the sections of data with expressive words, symbols or exclusive recognising names. Every time researchers discover a significant section of text, they appoint a label or code to signify that specific section. Qualitative transcripts can be hand-coded using colour-code structures (Creswell, 2009:188). Another way to code the data is by using a qualitative computer software programme to help code, arrange, and categorise the data that will be beneficial in the writing of the study. Text documents can be stored by the software programme for the analysis. It allows researchers to label and block text sections with the codes so that the sections can effortlessly be regained. The programme arranges the codes into an illustration, which makes it possible to map and see the connection between them. The programme also seeks for sections of text that comprise numerous codes (Creswell & Clark, 2011:208). In this study, the researcher made use of the computer software programme, Atlas.ti (http://www.atlasti.com) which originated in Germany, to code the transcribed interviews and to assist with the analysis of the qualitative data. The program

allowed the researcher to categorise the text, the coding, notes, and conclusions.

- Produce *themes* or categories, as well as a *description* of the situation or people for analysis. A description includes a comprehensive interpretation of data about places, people, or occasions in a setting. Thus, the coding can be used to produce a small number of themes or categories. These themes are the main results and are regularly used to generate headings in the results sections of the study. By using Atlas.ti, the researcher identified the themes and descriptions of the study.[5]
- Develop how the themes and description will be *represented* in the qualitative report. A discussion that comments on the sequence of events, a comprehensive discussion of numerous themes or a discussion with interrelated themes, is how the data can be represented. Additionally, figures, tables, or graphics can also be used.
- *Interpreting* the data is the final step in the data analysis procedure. The lessons learned from the data analysis can be a researcher's individual interpretation or an implication originating from a comparison of the results where the data were collected from the literature.

To draw final conclusions, the quantitative and qualitative data were combined to get a deeper meaning of the results. The conclusions from the qualitative data (the interviews) supported and enhanced the conclusions from the quantitative data (the questionnaire) to result in enriched meaningful conclusions and suggestions.

3.8 Reliability and validity

Researchers aspire to choose an instrument that states individual results that are reliable and valid (Creswell, 2008:169). These two concepts necessarily go together in multifaceted ways, occasionally overlap and at other times are mutually exclusive. If results are not reliable, they are not valid. Therefore, this implies that it is

[5] Network views of the codes and categories identified by using Atlas.ti can be seen in the attached addendum 3 of this dissertation.

necessary for results to firstly be “stable and consistent” (Creswell, 2008:169) (reliable) and then meaningful (valid). The more reliable the results of an instrument are, the more valid the results may be. Consequently, the ultimate circumstances occur when results are both reliable and valid.

The reliability and validity are therefore discussed in detail in 3.8.1 and 3.8.2.

3.8.1 Reliability

3.8.1.1 Quantitative research

Creswell (2008:169) defines the reliability of an instrument in quantitative research as follow:

> *“Reliability means that the scores from an instrument are stable and consistent. Scores should be nearly the same when researchers administer the instrument multiple times at different times. Also, scores need to be consistent. When an individual answers certain questions one way, the individual should consistently answer closely related questions in the same way”.*

There are five obtainable variables, which researchers can use to assess the reliability of an instrument, i.e. test-retest, alternate forms, alternate forms and test-retest, interrater and internal consistency reliability (Creswell, 2008:169-17; Pietersen & Maree, 2007c:215). One or more of these forms of reliability can be used. Creswell and Clark (2011:211) also emphasise that it is necessary to ascertain the reliability of results before the evaluation of their validity can be attended to. For this study, the researcher made use of the internal consistency reliability: This means that the scores of the individuals were internally consistent throughout the instrument’s items. If the participants answer the questions in one specific way at the beginning of the questionnaire, then they should complete the items later in the questionnaire in a related way (Creswell, 2008:171 and Pietersen & Maree, 2007c:216). Thus, the questionnaire was administrated once, there was only one version of the questionnaire and each participant in the study completed the questionnaire.

The responses' consistency can also be assessed in numerous ways, i.e. Kuder-Richardson split-half test, the coefficient alpha and the Spearman-Brown formula (Creswell, 2008:171). The coefficient alpha (Cronbach Alpha) was used in this study to check for internal consistency of the questionnaire. If the items of the questionnaire are recorded as continuous variables (e.g. strongly disagree to strongly agree), the alpha value supplies a coefficient to approximate the consistency of results on a questionnaire (Creswell, 2008:171). The Cronbach's alpha coefficient is established on the inter-item relationships, according to Pietersen and Maree (2007c:216). If there is a strong relationship between the items (questions), their internal consistency is high and the Cronbach's alpha coefficient will be close to one. Conversely, if the questions are inadequately formulated, and their relationship is not strong, the Cronbach's alpha coefficient will be close to zero. The following guidelines for the analysis of the Cronbach's alpha coefficient are in general acknowledged by researchers (Field & Miles, 2010:583-584):

- 0.6 – moderate to high reliability
- Less than 0.6 – low reliability

3.8.1.2 Qualitative research

In qualitative research, reliability plays a trivial role and correlates first and foremost to the reliability of numerous coders on a team to attain agreement on codes for segments in the text (Creswell & Clark, 2011:211). Thus, Gibbs (2007) (cited by Creswell, 2009:190) defines: "qualitative reliability means that the researcher's approach is consistent across different researchers and different projects". The reliability of interviews, for example, can be examined by the cross-checking (intercoder agreement) of codes by a person other than the researcher (Creswell, 2009:191 and Creswell & Clark, 2011:212). This agreement can be constructed on whether more than one coder concurs on codes used for similar sections in the text. Reliability subprograms or statistical processes in qualitative computer software packages can be used to establish the level of consistency of coding. For a trustworthy qualitative reliability, the consistency of coding must be at least 80% in concurrence, according to Miles and Huberman (1994) (cited by Creswell, 2009:191).

3.8.2 Validity

3.8.2.1 Quantitative research

Validity, according to Creswell (2008:169) implies that the individual's results from an instrument are significant, have value, and allow researchers to make valuable deductions from the sample being studied in respect of the population. In quantitative research, matters of validity are a concern for researchers at two levels:

- the value of the results from the instruments used, and
- the value of the deductions from the results of the quantitative analyses (Creswell & Clark, 2011, 210).

To evaluate validity for a study, according to Creswell and Clark (2011:210), researchers ascertain the validity of the instruments through content validity procedures, and uses criterion-related and construct validity to determine their results. The two types of validity, which were used in this study, are defined as follows:

- *Content validity* is the degree to which the instrument's questions and the results from these questions are illustrative of all the probable questions that researchers could ask regarding the content or competences.
- *Construct validity* is ascertained by deciding if the results from an instrument are noteworthy, significant, valuable, and have a point (Creswell, 2008:172-173 and Creswell & Clark, 2011:210).

Researchers using quantitative research also take into account the validity of the deductions they are proficient in obtaining from their results. The dangers to internal and external validity must be decreased according to the way researchers strategise their studies. Creswell and Clark (2011:211) define internal validity as the degree to which the researcher can deduce that there is a reason and result relationship among the variables. They define external validity as the degree to which the researcher can deduce that the results are also relevant to a larger population.

3.8.2.2 Qualitative research

Qualitative validity indicates that researchers assess the correctness of the results by utilising specific procedures (Gibbs, 2007) (cited by Creswell, 2009:190) and according to Creswell (2009:191), validity is one of the fortes of qualitative research. Multiple validity strategies must be used by researchers, which should improve researchers' competence to evaluate the accuracy of results and also to persuade readers of that accuracy. The following strategies were used, which were identified by Creswell (2009:191-192):

- *Triangulate* diverse data sources. Researchers construct confirmation for a theme or code from several sources or individuals (Creswell & Clark, 2011:212; Creswell, 2008:266). The researcher used the quantitative and qualitative data from the questionnaires and interviews to construct a comprehensible explanation for codes and themes resulting from the data.
- Use *member checking* to verify the accuracy of the qualitative results. Member checking (Creswell, 2008:267; Creswell, 2009:191; Creswell & Clark, 2011:211; Nieuwenhuis, 2007a:86) is where researchers establish the accuracy of the qualitative results by taking summaries or particular descriptions back to the participants and asking them whether the participants believe that the summaries are a correct expression of their experiences. The researcher of this study e-mailed the transcribed interviews to each of the interviewees individually so that they could verify the correctness of the transcribed interviews. All the interviewees verified the correctness of the transcribed interviews.
- Use *rich, thick description* to communicate the results. According to Creswell (2009:191), these descriptions can transfer the reader to the setting and offer the discussion a component of mutual understandings. The researcher described the interviews' setting in detail and gave numerous viewpoints about the different themes.
- Elucidate the *bias* the researcher conveys to the study. Self-reflection by researchers establishes honest and open descriptions and is a key attribute

of qualitative research (Creswell, 2009:192). The researcher explained how the interpretation of the results was done and formed by her background.

- Use *peer debriefing* to improve the accuracy of the subject matter. This procedure includes finding a person who assesses and asks questions about the qualitative part of the study so that other people will also be interested and have a good understanding of the study (Creswell, 2009:192). In this study, the researcher located a person who reviewed and questioned the subject matter which enhanced the validity.

3.9 Ethics

It is essential for researchers to engage in ethical issues in all the steps of the research procedure (Creswell, 2008:11). Ethical issues result from the collaboration with other people and the environment, particularly when there is probable or genuine conflict of interest (Mouton, 2001:239). Although researchers have permission to collect data through interviewing people, it cannot be to the disadvantage of the interviewee's right to privacy. Creswell (2008:13) goes further by stating that ethics should be the fundamental concern rather than the afterthought of one's research.

The ethical issues as pointed out by Creswell (2009:87-92) were used as a framework to address the ethical issues for this study.

3.9.1 Ethical issues in the research problem, aims and research questions

According to Punch (2005) (cited by Creswell, 2009:88), it is imperative throughout the identification of the research problem, that the research problem will be of value for the individuals who are studied and not only for the researcher. Furthermore, the aims and research questions must clearly be explained to the participants.

Because of the many years of experience, the researcher has of lecturing first-year Mathematics students at a South African university the researcher became aware of the non-engagement of students in Mathematics. Thus, the focus of this study was on the student engagement of first-year Mathematics students and how the student engagement influenced their first semester Mathematics module marks. The relevance of this study and the research resulting from it will definitely benefit not only the researcher and participants involved, but also other educators and researchers. The aims and research questions were explained to the participants in the consent form, which was given to them before they completed the questionnaire, and before the interviews were conducted with the interviewees.

3.9.2 Ethical issues in data collection

During the process of data collection, it is necessary for researchers to respect the participants and the research sites (Creswell, 2009:89). Many ethical issues can result from this research phase, and therefore the interests, compassions, and rights of those being studied must be protected (Mouton, 2001:243).

An informed consent form is a declaration that participants sign before they participate in research (Creswell, 2008:159). The consent form must affirm that researchers will assure the participant's specific rights and that when signing the form, they come to an agreement to be comprised of the research and accept the fortification of their rights.

By handing out an informed consent form (see addendum 4) to the participants of this study beforehand, they were given the opportunity to voluntarily and without obligation, complete the questionnaire. The questionnaire was completed during a tutorial session in the different classrooms and the interviews were conducted in a designated room, in a time slot agreed with each interviewee individually. The students' student number was asked only because their first-year, first semester Mathematics module marks were needed for the study. The students were however not identified in any other way. Although information is kept confidential, research sponsors and/or regulatory authorities may inspect research records. The students could have chosen to withdraw from the study at any time. There was no penalty in respect of their module marks for non-participation or withdrawal from the study and there was no risk involved for the participants. The students could contact the researcher and/or supervisors to obtain a copy of the results should they be interested. Ethical clearance was given by the North-West University Research Ethics Regulatory Committee (NWU-RERC). This implies that the NWU-RERC granted its permission that the research may be initiated. The students' Grade 12

Mathematics marks and their average Grade 12 marks were also needed for this study. These marks were retrieved from the university's official student database by the designated administrative personnel after the researcher's supervisor confirmed the researcher's requirement of the marks by a letter via e-mail.

3.9.3 Ethical issues in data analysis and interpretation

When data analysis and interpretation of both quantitative and qualitative data are done by researchers, issues can arise that ask for good ethical conclusions (Creswell, 2009:91). The researcher did not identify those participants who completed the questionnaire even though they had to give their student numbers and the six interviewees' identities were also protected by using pseudonyms for each of them. The quantitative data are kept on the premises in locked storage according to the university's and the Ethic committee's regulations for a period of five years. The audio recordings and the transcriptions of the interviews are stored electronically at various places (computer hard drive, memory stick, CD, etc.). The researcher, supervisors, and the statistical consultant are the only ones who had access to the data. According to Mouton (2001:244), the responsibility to respect confidentiality also relates to interviewers, administrative staff, coders, etc. who retrieved the data. Anyone who used the data at any stage of the research should be attentive of this responsibility.

3.9.4 Ethical issues in writing and disseminating of the research

According to Creswell (2009:92), "the ethical issues do not stop with data collection and analysis; issues apply as well to the actual writing and disseminating of the final research report". The researcher followed the following steps, suggested by Creswell (2009:92) and Mouton (2001:240) to diminish the ethical issues in the writing and disseminating of the research:

- No language or words were used that were biased against the participants because of their age, gender, ethnic or racial group, sexual orientation, or disability.

- The researcher did not falsify, subdue, or fabricate the conclusions in writing the research in order that the researcher's or an audience's requirements were met.
- Recognition was given to all the participants in the study.

3.10 Summary

In this chapter, a detailed description of the research design and methodology employed in this study was given. The mixed methods design used in this study is the explanatory sequential design as illustrated in Figure 8, in 3.3. The role of the researcher during the research process was described, the measuring instruments were discussed and the population and selection of participants were explained. This study began with the quantitative data collection, by administrating a questionnaire, and then data analysis was done by means of descriptive statistics. That was followed up with qualitative data collection by means of semi-structured, individual interviews, transcribing of the interviews and the analysis by Atlas.ti. Consequently, the results of the quantitative and qualitative research will be discussed in the next chapter.

CHAPTER 4
RESULTS

4.1 Introduction

In this chapter, the results of the analysis of the quantitative and qualitative data will be reported, as outlined in Chapter 3.

This chapter is portrayed according to the following sections:

Quantitative results: biographical data of participants; construct validity and reliability; descriptive statistics; correlations with module mark; and stepwise regressions.

Qualitative results: process of data analysis; identified categories and codes; background of interviewees and presentation and discussion of interview data.

4.2 Quantitative results

4.2.1 Biographical data of participants

- **Gender**
  A total of 304 students completed the questionnaire of which 208 (68.4%) were male students and 96 (31.6%) were female students.

- **Age**
  With regard to age, the ages of the participants ranged from 17 to 29 years. The majority (154) of the participants were 19 years old, which is 50.7% of the students. One hundred and twenty students (39.5%) were 18 years old. The other ages were represented by 9.8% of the participants (see Table 1).

- **Home language**

  The majority of the 304 participants spoke Afrikaans (n=258, 85.7%), while only 22 (7.3%) of the participants' home language was English. The other languages were represented by 7% of the participants (see Table 1).

- **Year in Grade 12**

  A total of 271 (89.1%) of the participants were in Grade 12 in 2014. Far fewer participants were in Grade 12 in 2013 and even less was in Grade 12 in 2003 – 2012 (see Table 1).

- **Study programme/degree**

  The majority of the participants registered to study Engineering, i.e. 185 (60.9%). Of those students who registered for a variety of BSc degrees, there were 107 (35.2%) who participated in this study. The rest of the participants were registered for other degrees (see Table 1).

- **Type of secondary school**

  The number of participants who attended an urban public school was 184 (60.5%). The other types of secondary schools were attended by 39.5% of the participants (see Table 1).

- **Type of residence**

  One hundred and fifty-three (50.3%) of the 304 participants lived in a dormitory or other on-campus housing. The rest of the participants resided in other types of residence (see Table 1).

4.2.2 Construct validity and reliability

4.2.2.1 Construct validity

In order to assure construct validity, a confirmatory factor analysis was done on each construct that was identified through the literature study. Some of the constructs were unidimensional. Those constructs, which were not unidimensional were split.

The items, which are part of the identified constructs, are as follows: Items 27 – 45 were constructed in such a way that the participants had to answer from their Grade 11 and 12 and WISN111 (first-year, first semester Mathematics module) perspective. Items 82 – 88 were asked from two perspectives: “from university” and “from the student”. The items not part of the identified constructs were part of the demographical section of the questionnaire (see addendum 1)

Construct 1:

Item 27: How often did you attend the Mathematics class with incomplete homework or assignments in Grade 12 and in WISN111?

Item 28: How often did you prepare two or more drafts of assignments/tutorials before the final version thereof was submitted in Grade 12 and in WISN111?

Item 29: How often did you reach conclusions based on your own analysis of numerical information (numbers, graphs, statistics, etc.) in a practical problem in Grade 12 and in WISN111?

Item 30: How often did you use numerical information to examine a real-world problem (unemployment, climate change, public health, etc.) in Grade 12 and in WISN111?

Item 31: How often did you evaluate what others have concluded from numerical information in Grade 12 and in WISN111?

Item 32: How often did you identify key information from assignments in Grade 12 and in WISN111?

Item 33: How often did you revise your notes after the Mathematics class in Grade 12 and in WISN111?

Item 34: How often did you summarise the course material (textbook/study guide) or what you have learned in the Mathematics class in Grade 12 and in WISN111?

Construct 2:

Item 35: How often did you evaluate your own philosophical views on a topic?

Item 36: How often did you try to understand someone else’s philosophical views better by imagining how a problem is perceived from his or her perspective?

Construct 3:

Item 38: How involved were you in culture activities (orchestra, chorus, theatre, art, debate, orators, Voortrekkers, boy scouts / girl scouts)?

Item 39: How involved were you in sports teams?

Item 40: How involved were you in the Representative Learner Council?

Item 41: How involved were you in publications (student newspaper, yearbook, etc.)?

Item 42: How involved were you in academic clubs or subject societies?

Item 43: How involved were you in religious youth groups?

Item 44: How involved were you in chess?

Item 45: How involved were you in community service or volunteer work?

Construct 4:

Item 51: How often did you ask another student to help you understand the WISN111 course material?

Item 53: How often did you prepare for exams by discussing or working through WISN111 course material with other students?

Item 54: How often did you work with other students on WISN111 projects, assignments or tutorials?

Item 55: How often did you talk about career plans with a lecturer?

Item 56: How often did you discuss your academic progress with a lecturer?

Construct 5:

Item 58: How often did you have discussions with people of a different race or ethnicity than your own?

Item 59: How often did you have discussions with people from a different economic background than your own?

Item 60: How often did you have discussions with people with other religious beliefs than your own?

Item 61: How often did you have discussions with people with other political views than your own?

Item 62: How often did you have discussions with people with other sexual orientations than your own?

Item 63: How often did you have discussions with people with disabilities?

Construct 6:

Item 64: How often did you study when there were other interesting things to do?

Item 65: How often did you find additional information for WISN111 assignments or tutorials when you don't understand the course material?

Item 66: How often did you participate in WISN111 discussions, even when you didn't feel like it?

Item 67: How often did you ask lecturers or tutors for help when you struggled with WISN111 assignments or tutorials?

Item 68: How often did you finish something in WISN111 you have started, in spite of challenges that you encountered?

Item 69: How often did you remain positive, even when you performed poorly in a WISN111 test, assignment or tutorial?

Construct 7:

Item 70: How difficult did you experience learning WISN111 course material?

Item 71: How difficult did you experience managing your time for WISN111?

Item 73: How difficult did you experience getting academic help with your studies?

Item 74: How difficult did you experience interacting with the WISN111 lecturers?

Construct 8:

Item 75: To what extent did you apply writing clearly and effectively at this university?

Item 76: To what extent did you apply speaking clearly and effectively at this university?

Item 77: To what extent did you apply thinking critically and analytically at this university?

Item 78: To what extent did you apply analysing numerical and statistical information at this university?

Item 79: To what extent did you apply working effectively with others at this university?

Item 80: To what extent did you apply using computing and information technology at this university?

Item 81: To what extent did you apply learning effectively on your own?

Construct 9:

Item 82: How important is it to you to receive a challenging academic experience?

Item 83: How important is it to you to receive support to succeed academically?

Item 84: How important is it to you to have opportunities to interact with students from different backgrounds (social, race/ethnic, religious, etc.)?

Item 85: How important is it to you to have support to manage your non-academic responsibilities (work, family, etc.)?

Item 86: How important is it to you to have opportunities to be involved socially?

Item 87: How important is it to you to have opportunities to attend campus activities and events?

Item 88: How important is the availability of learning support services (tutoring services, facilitation, reading lab, etc.) to you?

The items which were not part of the identified constructs, but part of the facets of student engagement, are mentioned below:

Item 18: For how many extra modules, which are not part of your programme / degree, are you registered this year?

Item 23: About how many papers, reports or other written tasks of 1 to 5 pages did you complete (Grade 11, 12 and WISN111)?

Item 24: About how many papers, reports or other written tasks of more than 5 pages did you complete (Grade 11, 12 and WISN111)?

Item 25: About how many hours did you spend preparing for the Mathematics class (studying, reading, doing homework, etc.) in a typical 7-day week in Grade 11 and 12 and in WISN111?

Item 26: About how many hours did you spend on extra-curricular activities (organisations, school publications, representative student council, sports, etc.) in a typical 7-day week in Grade 11 and 12 and the first semester?

Item 37: About how many hours in a typical 7-day week did you relax and/or socialise (time with friends, computer games, TV-games, conversing with friends online, etc. in Grade 12 and the first semester?

Item 46: To what extent did Mathematics challenge you to do your best work, especially in Mathematics in Grade 11 and 12 and the first semester?

Item 47: How many hours per week did you spend on doing additional work for an income in the first semester?

Item 48: How many hours per day did you study for WISN111 in a typical 7-day week?

Item 49: How many hours per week did you visit the Mathematics centre for additional help with WISN111?

Item 50: How many hours per day did you study for all your modules in the first semester in a typical 7-day week?

The items, which were not part of the identified constructs and also not part of the facets of student engagement, are mentioned next:

Item 15: What is the highest level of education completed by your father or paternal guide?

Item 16: What is the highest level of education completed by your mother or maternal guide?

Item 17: For how many modules are you registered this year (first and second semester)?

Item 72: How difficult did you experience paying for university expenses?

Table 2 shows the results after a confirmatory factor analysis was done on each construct.

Table 2: Confirmatory factor analysis on 4-point Likert-scale items of the questionnaire

Construct	n	MSA	Number of factors extracted	% of variance explained by extracted factors	Range of final communalities
Construct 1 (Q27 – Q34)	287	0.71	2	50.79%	0.44 – 0.59
Construct 2 (Q35, Q36)	289	0.50	1	71.75%	0.72 – 0.72
Construct 3 (Q38 – Q45)	288	0.78	2	45.24%	0.29 – 0.61
Construct 4 (Q51 – Q57)	300	0.60	3	66.12%	0.44 – 0.78

Construct 5 (Q58 – Q63)	300	0.82	1	50.50%	0.30 – 0.62
Construct 6 (Q64 – Q69)	298	0.72	2	52.56%	0.30 – 0.80
Construct 7 (Q70, Q71, Q73, Q74)	301	0.70	1	42.22%	0.21 – 0.55
Construct 8 (Q75 – Q81)	302	0.76	2	57.22%	0.40 – 0.75
Construct 9 (Q82 – Q88)	268	0.67	2	54.31%	0.24 – 0.75

Taking into account that the MSA values were higher than 0.5, all these factor analyses yielded appropriate results. Constructs 1, 3, 4, 6, 8, and 9 extracted more than one factor which resulted in splitting the constructs as the rotated factor pattern indicated. At Constructs 2, 5, and 7 only one factor each was retained, which assured these constructs' validity.

The facets of student engagement (see Figure 6, 2.6) are now summarised with the identified constructs in Table 3. "Expenses" (Q72) does not resort as part of one of the facets of student engagement, and is thus not part of Table 3.

Table 3: Facets of student engagement

Facets of student engagement		Description of constructs	Items numbers
Level of academic challenge	Construct 1	Assignments and notes (Grade 12 and WISN111)	27, 28, 33, 34
	Construct 1	Numerical information (Grade 12 and WISN111)	29 – 32
	Construct 2	Philosophical views (Grade 11, 12 and at university)	35, 36
	Construct 6	Perseverance	68, 69
	Construct 6	Engaged motivation	64 – 67
	Construct 7	Experience difficulty	70, 71, 73, 74
	Construct 8	Think, analyse, learn	77, 78, 80, 81
	Construct 8	Articulate Collaborative	75, 76, 79
		Challenge to do best (Grade 11, 12 and first semester)	46
		Study WISN111	48
		Study all modules	50
		Written tasks 1 – 5 pages (Grade 11, 12 and WISN111)	23
		Written tasks more than 5 pages (Grade 11, 12 and WISN111)	24
		Preparation Maths class (Grade 11, 12 and WISN111)	25
		Grade 12 Mathematic mark *	
Active and collaborative learning	Construct 4	Help from peers with studying	51, 53, 54
Supportive campus environment	Construct 9	Academic support important for student	82, 83, 88
	Construct 9	Academic support from university	82, 83, 88
	Construct 9	Non-academic support from university	84 – 87
	Construct 9	Non-academic support important for student	84 – 87

Facets of student engagement		Description of constructs	Items numbers
		Additional work	47
		Mathematics centre	49
Enriching educational experiences	Construct 3	Clubs at high school and university	38 – 43, 45
	Construct 3	Chess at high school and university	44
	Construct 5	Discussions with different groups	58 – 63
		Extracurricular activities (Grade 11, 12 and WISN111)	26
		Relax and socialise (Grade 12 and WISN111)	37
		Extra modules	18
Student-staff interaction	Construct 4	Discussions with lecturer	55 – 56

∗ *Although the Grade 12 Mathematics module mark is neither a construct nor an item for his study, it is important to make it part of the facets of student engagement.*

4.2.2.2 Reliability of constructs of questionnaire

The reliability of each construct of the questionnaire was determined by calculating a Cronbach's Alpha coefficient for the constructs, which were named according to their main context, as seen in Table 4.

Table 4: Constructs of questionnaire according to their main context

	Grade 11 and/or 12 or high school		WISN111	
Constructs	**Description of constructs**	**Cronbach's alpha (α)**	**Description of constructs**	**Cronbach's alpha (α)**
Construct 1	Assignments and notes (Q27, Q28, Q33, Q34)	0.68	Assignments and notes (Q27, Q28, Q33, Q34)	0.60
	Numerical information (Q29 - Q32)	0.64	Numerical information (Q29 - Q32)	0.70
Construct 2	Philosophical views (Q35, Q36)	0.61	Philosophical views (Q35, Q36)	0.67
Construct 3	Clubs (Q38 - Q43, Q45)	0.70	Clubs (Q38 - Q43, Q45)	0.70
	Chess (Q44)○		Chess (Q44)○	
Construct 4*			Study help from peers (Q51, Q53, Q54)	0.60
			Discussions with lecturer (Q55 - Q56)	0.60
Construct 5			Discussions with different groups (Q58 – Q63)	0.80
Construct 6			Perseverance (Q68, Q69)	0.50▲
			Engaged motivation (Q64-Q67)	0.60
Construct 7			Experience difficulty (Q70, Q71, Q73, Q74)	0.66
Construct 8			Think, analyse and learn (Q77, Q78, Q80, Q81)	0.69
			Articulate collaborative (Q75, Q76, Q79)	0.68

	Grade 11 and/or 12 or high school		WISN111	
Constructs	**Description of constructs**	**Cronbach's alpha (α)**	**Description of constructs**	**Cronbach's alpha (α)**
Construct 9			Academic support important for student (Q82, Q83, Q88)	0.60
			Academic support from university (Q82, Q83, Q88)	0.60
			Non-academic support important for student (Q84 - Q87)	0.69
			Non-academic support important from university (Q84 - Q87)	0.65

∗ *It was decided that the third factor of Construct 4, Q52 and Q57 could not be defined as a result of the lack of content validity.*

▲ *In research, where standardised questionnaires are rare, the Cronbach's Alpha coefficient value of 0.5 is regarded as useful (Breytenbach, 2016).*

○ *The item "Chess" (Q44) consists of only 1 question and therefore a Cronbach's Alpha coefficient was not done on this item.*

4.2.3 Descriptive statistics

Descriptive statistics can support researchers to summarise the overall tendencies in their data, offer an interpretation of how diverse the results might be, and provide understanding as to where results stand in relation to other results (Creswell, 2008:191).

4.2.3.1 Mean and standard deviation

The means and standard deviations of the variables regarding the facets of student engagement are summarised in Table 5.

Table 5: Means of constructs

Constructs	Mean	Std Dev
Relax and/or socialise in Grade 12	16.88	14.75
Relax and/or socialise at university	12.60	12.95
Number of modules registered for	9.96	2.93
Extracurricular activities in Grade 11 and 12	8.60	7.31
Study all modules	8.27	11.24
Preparation Maths class in Grade 11 and 12	6.94	7.81
Highest level of education father/paternal guide	6.55	1.79
Highest level of education mother/maternal guide	6.17	1.70
Extracurricular activities first semester	5.97	6.91
Preparation WISN111-class	5.92	7.06
Study WISN111	4.06	6.65
Academic support from university	3.41*	0.52
Academic support important for student	3.26*	0.55
Challenge to do best WISN111	3.19*	0.85
Think Analyse Learn	3.18*	0.53
Non-academic support from university	3.13*	0.59
Written tasks 1 – 5 pages in Grade 11 and 12	3.04	1.33
Articulate collaborative	2.97*	0.63
Challenge to do best in Grade 12	2.89*	0.92
Perseverance	2.80*	0.71
Loans	2.75*	0.93

Constructs	Mean	Std Dev
Non-academic support important for student	2.75*	0.68
Assignments, notes WISN111	2.60*	0.65
Study help from peers	2.57*	0.61
Philosophical views University	2.51*	0.84
Assignments, notes Grade 12	2.44*	0.77
Philosophical views Grade 11 and 12	2.42*	0.84
Written tasks 1 – 5 pages WISN111	2.39	1.17
Numerical information WISN111	2.38*	0.65
Numerical information Grade 12	2.37*	0.65
Engaged motivation	2.31*	0.62
Experience difficulty	2.29*	0.59
Additional work	2.28	7.02
Clubs at high school	2.21	0.65
Written tasks more than 5 pages Grade 11 and 12	2.19	1.43
Discussions with different groups	2.13*	0.68
Expenses	2.04	0.96
Written tasks more than 5 pages WISN111	1.58	0.99
Clubs University	1.56*	0.47
Chess at high school	1.54	0.96
Discussions with lecturer	1.24*	0.44
Chess University	1.11	0.44
Mathematics centre	0.96	4.21
Extra modules	0.19	0.84

* *Constructs on a 4-point Likert-scale*

In this study, for the constructs, which were yielded by means of a 4-point Likert scale, the decision was made to see the means 2.5 and above as tending to agree or strongly agree because on a 4-point Likert-scale, 2.5 is the midpoint. A number of these constructs have a mean of 2.5 and more, which indicates that the participants tend to agree and strongly agree with the constructs. The construct with the high mean of 3.41 is the construct, which includes the items about the academic support given by the university to the students. The students felt very strongly about the fact that the university gave them a challenging academic experience, that they received support to succeed academically and that there were learning support services available to them. Interestingly, the factor *"Discussions with lecturer*" has a mean of only 1.24. This low mean indicates that the participants almost never discuss either their academic progress or career plans with the lecturer and also almost never approach lecturers to assist them academically outside the classroom. The questions, which were not yielded by means of a 4-point Likert-scale, range from 0.19, for the number of extra modules registered for, to 16.88, which represents the amount of hours the participants spent on relaxing and socialising in Grade 12.

4.2.4 Correlations with module mark

Correlations with the module mark after confirmatory factor analysis was done, is shown in Table 6.

Table 6: Correlations with module mark

Constructs	Correlation with Module Mark
Grade 12 Mathematics mark	$0.68^{\blacktriangle}$
Average Grade 12 mark	$0.63^{\blacktriangle}$
Experience difficult (Q70,71,73,74)	-0.32^{Δ}
Challenge to do best WISN111 (Q46)	0.26
Think Analyse Learn (Q77,78,80,81)	0.23
Perseverance (Q68,69)	0.18
Discussions with different groups (Q58 - 63)	-0.17
Numerical information WISN111 (Q29 - 32)	0.17
Number of modules registered for (Q17)	0.14
Assignment, notes WISN111 (Q27,28,33,34)	0.14
Challenge to do best in Grade 12 (Q46)	0.14
Mathematics centre (Q49)	-0.13
Preparation Maths class in Grade 11 and 12 (Q25)	-0.13
Academic support important for student (Q82,83,88)	0.13
Study WISN111 (Q48)	-0.12
Written tasks 1 – 5 pages WISN111 (Q23)	0.11
Clubs at high school (Q38 - 43,45)	-0.11
Engaged motivation (Q64 - 67)	0.10

Constructs	Correlation with Module Mark
Expenses (Q72)	-0.10
Highest level of education of father or paternal guide (Q15)	0.08
Extra modules (Q18)	-0.08
Preparation WISN111-class (Q25)	-0.08
Additional work (Q47)	-0.08
Study all modules (Q50)	-0.08
Numerical information Grade 12 (Q29 - 32)	0.08
Highest level of education of mother or maternal guide (Q16)	0.07
Study help from peers (Q51,53,54)	0.07
Extracurricular activities in Grade 11 and 12 (Q26)	0.06
Relax and/or socialise at university (Q37)	-0.06
Non-academic support important for student (Q84 - 87)	-0.06
Philosophical views Grade 11 and 12 (Q35,36)	-0.06
Extra-curricular activities first semester (Q26)	0.05
Articulate collaborative (Q75,76,79)	0.04
Discussions with lecturer (Q55,56)	0.04
Written tasks more than 5 pages Grade 11 and 12 (Q24)	-0.04
Written tasks more than 5 pages WISN111 (Q24)	-0.03
Relax and/or socialise in Grade 12 (Q37)	-0.03
Chess at high school (Q44)	-0.03
Non-academic support from university (Q84 - 87)	-0.03
Assignment, notes Grade 12 (Q27,28,33,34)	0.03
Chess University (Q44)	-0.02
Written tasks 1 – 5 pages in Grade 11 and 12 (Q23)	-0.02
Clubs University (Q38 - 43,45)	0.01
Philosophical views University (Q35,36)	-0.01
Academic support from university (Q82,83,88)	0.005

▲ *Practical significant ($r \geq 0.5$)*

∆ *Medium correlation ($r \geq 0.3$)*

According to Cohen (1988), if the absolute value of r, $|r|$, the correlation coefficient, is greater or equal to 0.3, a medium correlation (that is a linear relationship) exists between the constructs. The correlations of the constructs "*Grade 12 Mathematics mark*" and "*Average Grade 12 mark*" are 0.68 and 0.63 respectively, which indicates that these two constructs have a practical significant correlation with the module mark. These two constructs are the only constructs, which had practical significant correlations with the module mark.

4.2.5 Stepwise regressions

In stepwise regression, the choices about the sequence in which predictors are inserted into the model are based on a purely mathematical criterion (Field & Miles, 2010:186-187). The statistical software searched for the predictor, available from the constructs, which best predicted the resulted construct. In this study, the best predictor was the Grade 12 Mathematics mark. Thus, the predictor, which had the highest correlation with the results was selected. This predictor considerably enhanced the ability of the model to predict the result, and therefore the Grade 12 Mathematics mark was kept in the model and the computer searched for a second predictor. The construct, which had the biggest semi-partial correlation with the result, was the criterion used for selecting a second predictor (Field & Miles, 2010:187). To eliminate multi-collinearity, the variable "Average Grade 12 mark" was not included in any of the stepwise regression models. The correlation between the Grade 12 Mathematics mark and the Average Grade 12 mark was 0.78, which is very high. Two additional regression models were also fitted for the engineering and natural science students since the engineering and natural science students were well presented in the study population.

The following variables were fitted into each regression model:

- Gender (Q2)
- Age (Q5)
- Highest level of education completed by father or paternal guide (Q15)
- Highest level of education completed by mother or maternal guide (Q16)
- Number of modules the participants is registered for the first and second semester (Q17)
- Number of extra modules participants registered for (Q18)

- Number of hours the participants spend on preparing for the Mathematics class in Grade 11 and 12 (Q25)
- Number of hours the participants spend on preparing for the Mathematics class in WISN111 (Q25)
- Number of hours the participants spend on extra-curricular activities per week in Grade 11 and 12 (Q26)
- Number of hours the participants spend on extra-curricular activities per week presently. (Q26)
- Number of hours the participants relax and/or socialise per week in Grade 12 (Q37)
- Number of hours the participants currently relax and/or socialise per week (Q37)
- Number of hours the participants spend on doing additional work per week for an income in the first semester (Q47)
- Number of hours the participants studied for WISN111 per week (Q48)
- Number of hours the participants visited the Mathematics centre per week (Q49)
- Number of hours per day the participants studied for all their modules in the first semester in a typical week (Q50)
- Financial support by parents or relatives (Q89)
- Loans (Q90)
- Grants or scholarships (Q91)
- Work or personal savings (Q92)
- This university was your first, second, third, fourth or fifth choice or lower. (Q94)
- Construct 1: Assignments and notes (Grade 12 and WISN111) (Q27, Q28, Q33, Q34)
- Construct 1: Numerical info (Grade 12 and WISN111) (Q29 – 32)

- Construct 2: Philosophical views at university (Q35, 36)
- Construct 3: Chess at high school (Q44)
- Construct 4: Study help from peers (Q51, 53, 54)
- Construct 5: Discussions with different groups (Q58 – 63)
- Construct 6: Engaged motivation (Q64 – 67)
- Construct 6: Perseverance (Q68, 69)
- Construct 7: Experience difficulty (Q70, 71, 73, 74)
- Construct 8: Think, analyse, learn (Q77, 78, 80, 81)
- Construct 8: Articulate collaborative (Q75, 76, 79)
- Construct 9: Academic support from university (Q82, Q83, Q88)

The regression models for the study population, the engineering students and the natural science students, will be discussed in 4.2.5.1, 4.2.5.2 and 4.2.5.3.

4.2.5.1 Stepwise regression for the study population.

After the model had been fitted, the following constructs, as shown in Table 7, were the best predictors for the first-year Mathematics module mark for the study population. Take note, that in this study although the effect sizes of some constructs are small, in combination with other constructs, they are practical significant. ($R^2 > 0.25$)

Table 7: Stepwise regression model for the study population

Construct	Parameter estimate ■	Standard error	*p*-value (when random sampling is assumed)	Effect size (f^2)	Effect	R^2
Grade 12 Mathematics mark	0.88	0.09	0.1675	0.64▲	Large	0.38**
Engaged motivation	7.51	1.61	<0.0001	0.16∆	Medium	0.41**
Mathematics centre.	-2.16	0.55	0.0001*	0.11□	Small	0.46**
Think, analyse, learn	5.73	1.67	0.0008*	0.08□	Small	0.54**
Articulate collaborative	-4.37	1.39	0.0021*	0.07□	Small	0.55**
Preparation for Maths class in Grade 11 and 12	-0.44	0.156	0.0050*	0.06□	Small	0.50**
Academic support from university	-4.90	1.63	0.0032*	0.06□	Small	0.52**
Assignment, notes in WISN111	3.36	1.37	0.0152*	0.04□	Small	0.57**
Loans	2.01	0.87	0.0228*	0.04□	Small	0.58**
Discussions with groups	-2.64	1.21	0.0310*	0.03□	Small	0.59**

* *Statistically significant on a 0.05 level according to stepwise regression procedure*

**R^2 – *<0.13: Not practical significant*

– *0.13 - 0.25: Significant*

– *>0.25 Practical significant*

- ■ *The sign of the parameter estimate indicates whether the predictor has a positive or negative influence on the Mathematics module mark.*
- ▲ *Large effect*
- ∆ *Medium effect*
- □ *Small effect*

4.2.5.1.1 Discussion of constructs

- **Grade 12 Mathematics mark**

  According to the effect size of 0.64, the Grade 12 Mathematics mark has a large effect on predicting the students' first semester Mathematics module mark. Thus, the better their Grade 12 Mathematics mark is, the better they will perform in Mathematics in the first semester.

- **Engaged motivation**

  The effect size of 0.16 for this construct is medium and thus it indicates that being engaged and staying motivated had to some extent a positive influence on the students' module mark. The construct includes study when there were other interesting things to do, found additional information to do assignments or tutorials when they did not understand the module material, participated in discussions about the material, even when they did not feel like it and asked for help from lecturers or tutors when they struggled with assignments or tutorials.

- **Mathematics centre**

  The number of hours the students visited the Mathematics centre is, although small in effect size (0.11) on its own, but in combination with other predictors also with small effect sizes, a predictor, which predicted the module mark. By taking into account the sign of the parameter estimate, namely negative, it means that the more hours the students visited the Mathematics centre, the lower their Mathematics module mark tends to be.

- **Think, analyse and learn**

  The students' ability to think critically and analytically, analyse numerical and statistical information, use computing and information technology and learn effectively on their own, all in their academic work, is also a predictor of the module mark. However, small in effect size (0.08), this predictor, in combination with other predictors also with small effect sizes, helped to predict the module mark positively.

- **Articulate collaborative**

  Although small in effect size (0.07) on its own, but in combination with other predictors also with small effect sizes, the construct "*Articulate collaborative*" helped to predict the module mark. Nevertheless, the more the students write and speak clearly and effectively in their academic work and work effectively with others, the lower the Mathematics module mark tends to be. This conclusion can be made according to the negative sign of the parameter estimate.

- **Preparation for Maths class in Grade 11 and 12**

  In combination with other predictors also with small effect sizes, another predictor of the Mathematics module mark, which is small in effect size (0.06), is the number of hours students spend preparing for the Mathematics class in Grade 11 and 12 in a typical seven-day week. By taking into account the negative sign of the parameter estimate, it means that the more time they spent preparing for the Mathematics class per week in Grade 11 and 12, the lower the student's module mark tends to be.

- **Academic support from university**

  Although it was important to students to receive a challenging academic experience from the university and support to help them succeed academically, it had a small influence on the Mathematics module mark. This is confirmed by the effect size of 0.06. Even though small in effect size on its own, in combination with other predictors also with small effect sizes, this construct helped to predict the module mark. The availability of learning support services, such as tutoring services, facilitation, reading labs, etc., is also important to the students. With regard to the sign of the parameter estimate, which is negative, it means that the more support the students receive from the university, the lower their Mathematics module mark tends to be.

- **Assignment, notes in WISN111**

  Although small in effect size (0.04) on its own, in combination with other predictors also small in effect size, this construct helped to predict the module mark positively. This construct consists of the following aspects: the attendance of the Mathematics class with incomplete homework or assignments; the preparation of two or more drafts of assignments or tutorials before the final version thereof was submitted; revision of the students class notes after the Mathematics class; and doing summaries of the module material (textbook/Study Guide) or what they have learned in the Mathematics class.

- **Loans**

  To pay for their education expenses (tuition, fees, books, accommodation, etc.) with loans also helped to predict the module mark in a positive way, in combination with other predictors with small effect sizes, even though, on its own, this construct has a small effect size of 0.04.

- **Discussions with different groups**

  In combination with other predicators with also small effect sizes, the construct "*Discussions with different groups*" helped to predict the Mathematics module mark, even though, on its own, the effect size (0.03) is small. The negative sign of the parameter estimate indicates that the more the students participated in discussions with different groups of people, the lower their Mathematics module mark tends to be.

4.2.5.2 Stepwise regression for the engineering students

The constructs, which are the predictors for the Mathematics module mark for the engineering students are discussed. After the model had been fitted, the following constructs, as shown in Table 8, were the best predictors for the first-year Mathematics module mark for the engineering students. Take note, that in this study, although the effect sizes of some constructs are small, in combination with other constructs, they are practical significant ($R^2 > 0.25$).

Table 8: Stepwise regression model for the engineering students

Construct	Parameter estimate ■	Standard error	p-value (when random sampling is assumed)	Effect size (f^2)	Effect	R^2
Grade 12 Mathematics mark	1.31	0.15	<0.0001	1.02▲	Large	0.37**
Discussions with different groups	-5.81	1.52	0.0003*	0.19∆	Medium	0.43**
Academic support from the university	-7.85	2.10	0.0004*	0.18∆	Medium	0.46**
Highest education level of father or paternal	1.90	0.62	0.0033*	0.12□	Small	0.53**
Highest education level of mother or maternal	-1.73	0.63	0.0076*	0.10□	Small	0.56**
Preparation for Maths class in Grade 11 and 12	-0.62	0.23	0.0073*	0.10□	Small	0.50**
Chess in high school	-2.98	1.13	0.0112*	0.09□	Small	0.58**
Study all modules	0.47	0.21	0.032**	0.06□	Small	0.61**

* *Statistically significant on a 0.05 level according to stepwise regression procedure*

**R^2 *–- <0.13: Not practical significant*

–- 0.13- 0.25: Significant

–- >0.25 Practical significant

- ■ *The sign of the parameter estimate indicates whether the predictor has a positive or negative influence on the Mathematics module mark.*
- ▲ *Large effect*
- ∆ *Medium effect*
- □ *Small effect*

4.2.5.2.1 Discussion of constructs

- **Grade 12 Mathematics mark**

  According to the effect size of 1.02, the Grade 12 Mathematics mark had a large effect on predicting students' first semester Mathematics module mark. This effect size is even larger than the effect size of the whole population for this specific construct. One possible reason why their Grade 12 Mathematics marks are such a practical significant predictor for their module marks, is that the engineering students are selected to study engineering and that their Grade 12 Mathematics mark must be 70% and higher to be eligible for any Engineering programme.

- **Discussions with different groups**

  The effect size of 0.19 for this construct indicates that having discussions with people from various groups had to some extent an influence on the students' Mathematics module mark. By taking into account the negative sign of the parameter estimate, it indicates that the more they participated in discussions with people of different groups, the lower their Mathematics module mark will turn out to be.

- **Academic support from the university**

  The academic support the students receive from the university has an effect size of 0.18. This indicates that this construct is a predictor of medium size of the Mathematics module mark. Furthermore, the more academic support the students receive from the university, the lower their Mathematics module mark will be, if the negative sign of the parameter estimate is taken into account.

- **Highest education level of father or paternal guide**

  Although the construct "*The highest level of education completed by students' fathers or paternal guides*", has on its own, a small effect size of 0.12, in combination with other predictors also small in effect size, this construct helped to predict the module mark positively.

- **Highest education level of mother or maternal guide**

  Even though small in size (0.10) on its own, this construct, in combination with other predictors also with small effect sizes, helped to predict the Mathematics module mark. In contrast with the level of education of the students' fathers, the negative sign of the parameter estimate for this construct means that the higher the mother's level of education, the lower the students' Mathematics module marks will become. It is worth mentioning that this construct appears only in the regression model of the engineering students.

- **Preparation for Maths class in Grade 11 and 12**

  The number of hours the engineering students spent preparing for the Mathematics class in their last two years in secondary school, has on its own, a small effect size (0.10). However, this construct, in combination with other predicators with small effect sizes, helped predict the Mathematics module marks of these students. By taking into account the negative sign of the parameter estimate, it suggests that even though these students spent many hours preparing for the Mathematics class in Grade 11 and 12, their first-year Mathematics module marks tend to be lower.

- **Chess at high school**

  In spite of the small effect size of 0.09 for this construct on its own, in combination with other predictors also with small effect sizes, it did help to predict the module mark. Considering the sign of the parameter estimate, which is negative, it indicates that the more the students were involved in chess at high school, the lower their first-year Mathematics module mark will become.

- **Studying for all modules**

  Even though small in size (0.06) on its own, this construct in combination with other predictors also with small effect sizes, assisted in the prediction of the module mark positively. Thus, the number of hours the engineering students studied per day for all of their modules in a week did predict their module mark. Interestingly, this construct appears only in the regression model of the engineering students.

4.2.5.3 Stepwise regression for the natural science students

After the model had been fitted, the following constructs, as shown in Table 9, were the best predictors for the first-year Mathematics module mark of the natural science students. There were not enough data points and too many predictors to fit a meaningful theoretical regression separately for male and female natural science students. Take note, that in this study, although the effect sizes of some constructs are small, in combination with other constructs, they are practical significant ($R^2 > 0.25$).

Table 9: Stepwise regression model for the natural science students

Construct	Parameter estimate ■	Standard error	p-value (when random sampling is assumed)	Effect size (f^2)	Effect	R^2
Grade 12 Mathematics mark	0.49	0.11	<0.0001	0.40▲	Large	0.28**
Philosophical views at university	-5.27	1.22	<0.0001	0.38▲	Large	0.67**
Perseverance	6.26	1.44	<0.0001	0.38▲	Large	0.58**
Chess in high school	4.55	1.11	0.0002*	0.34∆	Medium	0.61**
Numerical info in Grade 12	6.71	1.98	0.0014*	0.23∆	Medium	0.70**
Help with study from peers	-4.19	1.55	0.0092*	0.15∆	Medium	0.72**
Engaged in motivation	4.35	1.70	0.0135*	0.13□	Small	0.44**
Gender	4.85	2.00	0.0191*	0.12□	Small	0.75**
Experience difficulty in Maths	-4.16	1.71	0.019*	0.12□	Small	0.52**
Highest education level of father or paternal guide.	-1.26	0.53	0.0233*	0.11□	Small	0.77**

* *Statistically significant on a 0.05 level according to stepwise regression procedure*

**R^2 –- *<0.13: Not practical significant*

–- *0.13- 0.25: Significant*

–- *>0.25 Practical significant*

- ■ *The sign of the parameter estimate indicates whether the predictor has a positive or negative influence on the Mathematics module mark.*
- ▲ *Large effect*
- ∆ *Medium effect*
- □ *Small effect*

4.2.5.3.1 Discussion of constructs

- **Grade 12 Mathematics mark**

  According to the effect size of 0.40, the Grade 12 Mathematics mark had a large effect predicting the natural science students' first semester Mathematics module mark. Interestingly, this effect size is not as large as the effect size of the engineering students, which is 1.02. This can be because of the natural science students' selection criteria which are lower than the engineering students', specifically for Mathematics. Natural science students must have at least 60% for Mathematics to be eligible for specific Natural Science programmes.

- **Philosophical view at university**

  The effect size of 0.38 indicates that the philosophical view of the students at university also has a large effect on predicting the students' Mathematics module mark. Thus, the students often evaluated their own philosophical views on a specific topic and also tried to understand someone else's philosophical views better on a regular basis by imagining how a problem is perceived from his or her perspective. However, by taking into account the sign of the parameter estimate, which is negative, it indicates that the more often the students evaluated their own views and tried to understand other people's views, the lower their Mathematics module marks tend to be. Interestingly, this construct does not appear either in the regression model of the study population or the engineering students.

- **Perseverance**

  Another construct, which appears only in the regression model of the natural science students, is the perseverance construct. The effect size of 0.38 implies that perseverance also had a large effect on predicting the students' Mathematics module mark. Consequently, the students who did finish assignments which they started on a regular basis, in spite of challenges that they encountered, did perform better on the Mathematics module and staying positive even when they performed poorly on a Mathematics test, assignment or tutorial.

- **Chess in high school**

  The medium effect size of 0.34 for this construct suggests that being involved in chess at high school had to some extent a positive influence on the students' first-year, first semester Mathematics module mark. In contrast with the negative sign of the parameter estimate for this construct at the regression model of the engineering students, this construct has a parameter estimate with a positive sign. This means that the more the natural science students were involved in chess at high school the higher their module mark will become.

- **Numerical info in Grade 12**

  The students' use of numerical information in Grade 12 with the medium effect size of 0.23 had to some extent a positive influence on their first-year Mathematics module mark. The use of numerical information includes the following: reaching conclusions based on their own analysis of numerical information (numbers, graphs, statistics, etc.) in a practical problem; using numerical information to examine real-world problems; evaluating what others have concluded from numerical information and identifying key information from assignments. Again, this construct only appears in the regression model of the natural science students.

- **Help with study from peers**

  The effect size of 0.15 for this construct is medium and suggests that the help students received from their peers with their Mathematics studies had to some extent an influence on their Mathematics module mark in the first semester. This help includes that the students often asked another student to help them understand the Mathematics course material, and they explained the Mathematics course material on a regular basis to one or more students. To prepare for exams, they discussed or worked through the Mathematics course material with other students on a regular basis and also worked frequently with their peers on Mathematics projects, assignments or tutorials. By taking into account the negative sign of the parameter estimate, it implies that the more the students received help on a regular basis from their peers with their Mathematics studies, the lower their module marks will become. It is interesting to note that this construct only appears in the regression model of the natural science students.

- **Engaged motivation**

  Even though small in size (0.13) on its own, in combination with other predicators also with small effect sizes, this construct helped predict the module mark positively. This construct includes that the students studied on a regular basis even when there were other interesting things to do, found additional information for Mathematics assignments or tutorials when they did not understand the course material, participated in Mathematics discussions even when they did not feel like it and also stayed motivated because they asked the lecturers or tutors to help them when they struggled with assignments and tutorials.

- **Gender**

  The gender of the natural science students is a predictor of the module mark, in combination with other predictors also with small effect sizes, even though, on its own, the effect size is small (0.12). Since the males were indicated by a 1 and females by a 2 in the questionnaire, and the parameter estimate's sign is positive, the natural science, female students performed better than their male fellow students. It is worthwhile to mention that this item was not selected into either the regression model of the study population or the engineering students. Because of insufficient numbers of the male and female natural science students, the data were not split according to gender.

- **Experience difficulty in Maths**

  The construct "*Experience difficulty in first-year Mathematics*", small in size (0.12) on its own, in combination with other predictors also with small effect sizes, helped to predict the module mark. Given the negative sign of the parameter estimate, it indicates that the more the students experienced difficulty with the Mathematics module, the lower their module marks tend to be. In view of the negative sign of the parameter estimate, it means that the more the students experienced difficulty with the Mathematics, the lower their module mark will become. Again, this construct does not appear in either the regression model of the study population or the engineering students.

- **Highest education level of father or paternal guide**

  Although small in size (0.11) on its own, this construct, in combination with other predictors also with small effect sizes, helped to predict the Mathematics module mark. By taking into account the negative sign of the parameter estimate it means that the higher the father's level of education, the lower the students' Mathematics module marks will become. The difference in the parameter estimate of this construct at the regression model of the engineering students and the natural science students is worth mentioning. In contrast with the level of education of the natural science students' fathers, this construct predicted the engineering students' module mark in such a way that the higher the father's level of education was, the higher the module mark will become.

4.3 Qualitative results

A total of six Mathematics students, who were first-year students in 2015, were interviewed individually by the researcher using semi-structured interviews. See 3.6.2.1 for a list of the questions asked. All the interviews were recorded, transcribed verbatim and then analysed.

4.3.1 Process of data analysis

For the analysis of the qualitative data (interviews), the computer programme, ATLAS.ti 7.5.13 was used. The process of data analysis was as follows:

- The data from the transcripts of the interviewees were ascribed to a single hermeneutic unit;
- The transcripts of each interview were saved as primary documents in the hermeneutic unit;

- The information, which was applicable was separated from the unrelated information;
- The applicable information was split into numerous text divisions;
- The categories, which emerged from the text were coded with *a priori* codes and the text divisions were linked to the categories;
- To illustrate the different categories, which emerged from the text, networks were drawn.

Figure 10 gives a schematic illustration of the data analysis process.

Figure 10: Process of data analysis

4.3.2 Categories and codes

The twelve categories identified from the text and the relevant codes are illustrated in Figure 11.

Figure 11: Categories and codes

4.3.3 Background of interviewees

Interviewee 1 was an Afrikaans-speaking, female student who received home schooling. Her preference was to be interviewed in English because she is bilingual. The interviewee's Grade 12 Mathematics mark was 74% and her first semester module mark 70%. This interviewee studied Engineering. The pseudonym used for this student by the interviewer was F_Eng_Blonde1.

The second interviewee was an Afrikaans-speaking, male student who attended an urban public secondary school and studied Engineering. He chose to do his interview in Afrikaans. His Grade 12 Mathematics mark was 81% and he obtained a Mathematics module mark of 50% for the first semester. M_Afr_Glasses2 was the pseudonym used for him.

An Afrikaans-speaking, female student, who studied Actuarial Sciences, was the third interviewee who attended a rural public secondary school. She chose to be interviewed in Afrikaans. The Grade 12 Mathematics mark she obtained was 70% and her first semester Mathematics mark was 41%. The pseudonym F_Afr_Smile3 was used for her.

[6]Interviewee 4 who studied Engineering was an English-speaking, male student who attended a private secondary school. His home language is IsiZulu, but the interview was done in English. The mark he obtained for Mathematics in Grade 12 was 97%, and for the first semester Mathematics, he received a mark of 82%. The pseudonym used for the interviewee was M_Eng_Bright4.

The fifth interviewee with pseudonym M_Eng_Shy5 was an English, male student who was interviewed in English and who studied Engineering. He attended an urban public secondary school and obtained a mark of 86% for his Grade 12 Mathematics. His first semester Mathematics mark was 46%.

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[6] Interviewee 4 emerges as an interesting participant in this study with unique characteristics resulting from his interview. Apart from being the best performer of the interviewees, other aspects in terms of student engagement have presented themselves. These will be highlighted in the summary of the qualitative data in 4.4 according to addendum 2.

Interviewee 6 was an English-speaking, female student who chose to be interviewed in Afrikaans because she is bilingual. Her home language is, however, Sesotho. She attended an urban public secondary school, studied Natural Science, and obtained a Grade 12 Mathematics mark of 89%. Her first semester Mathematics module mark was 65%. The interviewer used the pseudonym F_Afr_Friendly6 for her.

4.3.4 Presentation and discussion of the semi-structured, individual interviews

Reporting back on the interviews is structured according to each individual interviewee's interview. The criterion, which the researcher used to differentiate between the six interviewees, was their performance in the first-year, first semester Mathematics module. The reason was that this is the primary focus of this study. The primary documents, which were created in Atlas.ti of each interviewee, will be used in the discussion. The researcher will use only those significant quotations, which are relevant to a specific code.

The decision was made to discuss those interviewees who were categorised as good, average and poor performers, after each other. For the discussions which follow, the categories will be presented in bold and the codes in italic. After each quotation, the numbers in brackets have the following meaning: (P3:37) means primary document 3 in the hermeneutic unit created in Atlas.ti., quote 37 of the specific interviewee.

4.3.4.1 Interviewee 1: Good performance

Table 10: Categories and codes used by interviewee 1 and summary of interviewee's responses

Categories	Codes	Summary
Academic help	Lecturer	Pursued help regularly
	Maths centre	Visited the centre during lunch time or in the evenings
	Peers	From those who knew something
	Tutor	Those who helped her the best
Classes	Number of classes	Full timetable
Lived experience	Experience with Maths	Interesting and awesome
	Understanding Maths	Try to understand the work
Marks	Grade 12	Very good mark
	Maths 1^{st} year	Satisfied but wanted a better mark
Material	Difficulty of material	She struggled with theorems and integrals
Preparation	Classes	She tried to prepare for class to see what she understood
	Tests	She used video recordings of the class, extra study material, tutorials and old tests
Progress	Discussed with lecturer	On a regular basis
Self-efficacy	Perseverance with problems	She did not despair easily. She tried to get to the correct answers
	Homework	She did the homework given in class and additional exercises to make sure she understand the work
Study environment	General info	If students make an effort they are not supposed to have problems
	Type of school	Home-schooled
Time	Study time per day	1 – 2 hours and also during lunch time
	Time management	Difficult because of many classes

This interviewee did pursue **academic help** from her *lecturer* "about three out of the five days, working days" (P3:37), because the lecturer needed to make many concepts understandable to the student. She also pursued help in the *Mathematics centre "…*sometimes during my lunch…" (P3:48) and Wednesday evenings when she had the entire evening off. In addition to help from her lecturer, she asked the *peers* "…what I know in the classes they know what's going on." (P3:11) She also pursued help form the *tutors* "…I thought helped me better." (P3:47)

The interviewee mentioned the *number of classes* she had to attend on a daily basis with the following quotation: "… we had so many **classes.**" (P3:31)

The **lived experience** the interviewee had about her *experience with Mathematics,* was "very interesting", and after some explaining, "I found the process, uhm, how can I say it? It was awesome." (P3:17) She was also fascinated with the different elements of Mathematics and how people try to understand it. After the interviewer asked her whether she really tried to *understand the Mathematics* or whether she studied to pass only and applied the techniques without understanding, she answered shortly: "I try to understand it… (Laughter)" (P3:39)

The interviewee was satisfied with her 70% *Maths 1st year* **mark**, but "I would have liked to have more marks" (P3:4), but since she was home-schooled, "I was far more behind than the other students." (P3:4)

Two sections of the **material** of the Mathematics module with which the interviewee experienced *difficulty*, were theorems,"…when they put it in mathematical language" (P3:27) and integration.

It was clear that the interviewee "tried to go over the material before we start the class." (P3:18), which indicates that she made an effort to do **preparation** for the Mathematics *classes* "to see what I understand…" (P3:18). Additional technology resources, such as video recordings of the lectures and extra study material the interviewee tried "…and go through the class work, through the homework, all the tutorials and possibly all the tests." (P3:18, 23), which helped the interviewee to prepare for *tests*.

The interviewee said, “I *discussed* my **progress** a lot of the times with my *lecturer*…” (P3:14) She indicated that she was not satisfied with her progress “because I felt that I was working really hard and my marks didn’t show it…” (P3:14)

The **self-efficacy** of the interviewee was evident when she indicated her *perseverance with problems*.

> *Uhm, most of the times I try to get the right answer and if I don’t get the right answer then I’ll go back and try and to see where I went wrong. I try to make sense of it for myself but ja most of the times I wouldn’t go to sleep if I didn’t finish my work. (P3:20)*

She also pointed out that “I try hard” (P3:41) to get the solutions of problems and do not despair easily. She did the *homework* given in class, and “extra exercises just to make sure that the entire process makes sense, and I understand what I am doing”. (P3:22)

When the interviewee was asked whether she wanted to bring any *general information* about the Mathematics module under the interviewer’s attention, she indicated that if students put in their own efforts they are not supposed to have a problem. The **study environment** of the interviewee could be a factor, which influenced the interviewee’s performance since she mentioned that she was home-schooled and not in the same *type of school* as most of her fellow students.

The average *study **time** per day* the interviewee spent on the Mathematics module was 1 to 2 hours and she mentioned that “A lot of the time my lunch time wasn’t lunch…” (P3:45) Furthermore, she pointed out that she spent some evenings on the Mathematics module. The interviewee indicated that it was difficult for her to *manage her time* efficiently because “we had so many classes and then you have a lot of homework for all the different subjects…” (P3:46)

4.3.4.2 Interviewee 4: Good performance

Table 11: Categories and codes used by interviewee 4 and summary of interviewee's responses

Categories	Codes	Summary
Academic help	Lecturer	Difficult to pursue help
	Maths centre	Struggled to visit centre
	Refresher course	Helped immensely
	Peers	Did not seek help
	Tutor	Did pursue help because tutors were excellent
Classes	Number of classes	Full timetable
Lived experience	Experience with Maths	Challenging but enjoyable.
Marks	Grade 12	Excellent mark
	Maths 1st year	He was satisfied with his mark
Material	Difficulty of material	Experienced no difficulty, but felt stressed
Participation	Class	Asked questions during class time
Preparation	Revision	After hours
	Classes	In beginning of semester
Progress	Discussed with lecturer	After tutorial sessions
Self-efficacy	Perseverance with problems	Stayed long with problems and sometimes too long during tests/exams
	Homework	Did homework of tutorial during weekends
Study environment	Translation to English	Positive experience
	Residence	Lived in hostel on campus
Time	Study time per day	Average 3 hours, but not always enough
	Time management	Sometimes struggled

It was difficult for this interviewee, in contrast with the previous interviewee who also performed well, to pursue **academic help** from his *lecturer* outside class time because "during that limited space of time, if my lecturer was a bit busy…" (P5:15), "…it was difficult to get to the lecturers in their office hours…" (P5:22) The interviewee also struggled to visit the *Mathematics centre* during the hours it was open since "…during the day like we always had like classes. So... we would never like to make it to the Mathematics centre on time to get like some help.” (P5:49) If he maybe had an hour or so to visit the Mathematics centre, “there were usually a lot of people around and we couldn’t really get that much help. (P5:49) When asked about the interviewee’s experience of the *refresher course*, which he attended at the beginning of the year, the interviewee answered: “…the refresher course did wonders like for us.” (P5:37) He explained that “…it allowed us to like to get in contact with the material before we actually got in contact with the material.” (P5:37) Pursuing help from his *peers* was not part of the interviewee’s way to get academic help since “I only stay with Master’s and Honour’s students…” (P5:18) and he was not really a social person, which made it difficult for him to ask his fellow students in class. The interviewee gave an extended explanation why he made use of the help of *tutors* to assist him with any Mathematics questions or problems.

> *…they were really excellent. So, I like the way that they would explain the concept before and get your answer. (P5:48)*

Just like the previous interviewee, this interviewee indicated that he had many ***classes*** per day since he studied Actuarial Sciences.

The *experience of Mathematics*, which indicated the **lived experience** the interviewee had with Mathematics “…was challenging, but although I’ve... I always had to work hard like in Mathematics. I’ve some of always enjoying it”. (P5:31)

The interviewee said he was not necessarily an intelligent learner, but did work hard to make sense of the Mathematics and therefore his *Grade 12 Mathematics* **mark** was excellent. “Because my participation mark and my final mark were just a percentage off...” (5:13), the interviewee was satisfied with his good *first-year Mathematics mark* although he thought he missed his distinction after he wrote the first examination.

Although the interviewee did not experience any *difficulty with the* ***material*** of the Mathematics module, he felt stressed and the many other modules made it difficult for him.

The interviewee showed **participation** in the Mathematics *class* by asking questions to the lecturer and taking notes of the lecture.

Doing *revision* after hours ("…every night when I studied, I usually studied the stuff from the previous day and the current day…" (P5:33)), was possible for the interviewee as part of his **preparation** for the Mathematics module. In the beginning of the semester, the interviewee did preparation "in the *class* for the class" (P5:33), but could not maintain it. Because of an increasing stress level, the interviewee "…could never get to study for the following day…" (P5:33)

He *discussed his* **progress** *with his lecturer* "…usually after every tutorial..." (P5:26), beginning "…I think it was the 4th week when we have written about four tutorials." (P5:26)

The *perseverance with problems* which the interviewee demonstrated indicated his **self-efficacy** in the Mathematics module. He was "...not used to just given up easily on any questions." (P5:34). By staying too long with a problem and trying to get to the correct answer, "…slowed down like my speed when it comes to tests and exams." (P5:34) Doing tutorial *homework* for the following week during weekends, the interviewee gained knowledge about what he did not really understand until that point.

Translation to English and his *residence* were part of the interviewee's **study environment**, which could have had an influence on his performance. His experience with the translation of the Mathematics classes to English was very positive and he mentioned a specific translator, Paul, who was "actually good." (P5:25) He resided at "Oppierif" (P5:43), a hostel on campus, which made it easy for him to get to campus without any transportation problems.

The ***time*** the interviewee *studied per day* for Mathematics in a typical seven-day week, was on average three hours, because "…it takes like repetition so that you understand it best…" (P5:38) He also indicated that the 3 hours per day was not really enough "…but I always made time, like it was between 10 and I think 1 every night." (P5:39), and that "I knew like the only time I could actually do it was on weekends, so my schedule always like prepared for the weekend…" (P5:9) The interviewee sometimes struggled with his *time management* of the Mathematics module, since "…I have shorter time, like, and more courses to do which are more difficult than which I was facing in matric." (P5:12) and that resulted in "…sometimes I would study less." (P5:12) Although he found it difficult to manage his time, he indicated that "…I knew I had to continue pushing through…" (P5:12)

4.3.4.3 [7]Interviewee 6: Average performance

Table 12: Categories and codes used by interviewee 6 and summary of interviewee's responses

Categories	Codes	Summary
Academic help	Lecturer	Did not pursue help
	Maths centre	Visited centre only when she had questions about weekly tutorial
	Refresher course	Helped her to prepare for the first semester (Mathematics and big classes)
	General	Asked help from students on academic board
	Tutor	Received great help
Classes	Number of classes	Full timetable
Lived experience	Experience with Maths	Pleasant although her marks did not show it
	Understanding Maths	She tried to understand techniques
Marks	Grade 12	Distinction
	Maths 1st year	Not satisfied with mark. Hostel activities influenced her performance
Material	Difficulty of material	Experience difficulty with inte-grals
Preparation	Revision	Worked through class notes and study guide
	Classes	Went unprepared and thus did not ask questions in class
	Tests	Did old tests, not really exercises
Self-efficacy	Perseverance with problems	Worked on a problem for a long time because she wanted to know the correct answer

[7] Although interviewee 6 answered the questions in Afrikaans, the English translations of the quotes were used in the discussion.

Categories	Codes	Summary
Study environment	Transition from school to university	Not easy
Time	Study time per day	Average of 2 hours. Sometimes during weekends also
	Time management	Had difficulty with it.

The interviewee said she did not ask for **academic help** from her *lecturer* outside class time because "… I think the time… I saw it would take a lot of time…" (P1:25), since she stayed in a hostel far from the lecturer's office. The *Mathematics centre* was only visited by the interviewee when she had questions about the problems of the weekly tutorial, which she did beforehand, and "not when I struggled." (P1:5) The *refresher course* the interviewee attended at the beginning of the first semester, "…was good for me because it prepared me." (P1:52) Although the big class size was unfamiliar to her, because "… I was in a small school." (P1:52), she felt that the content of the course helped her to adjust to university. A *general* comment, which the interviewee made, was that she also asked the senior students who were on the academic board of the university to assist her with her academics.

The help the interviewee pursued from *tutors,* "…were of great help because they explained, like as if they understand how our brains work because they were also there." (P1:6)

Just like the previous two interviewees, this interviewee also indicated that she had many ***classes*** per day in the first semester.

The overall **lived experience** the interviewee had with the Mathematics module, was represented in her pleasant *experience with the Mathematics* module, although her marks did not reflect that. According to her, "…I felt like I did not put in, like... but it was good if I have put in, I would have obtained what I wanted." (P1:26) The *understanding of the Mathematics* was important to the interviewee since "…like for Mathematics, I try to understand techniques and to adjust what I understand." (P1:40)

The interviewee obtained a distinction for *Mathematics in Grade 12,* and thus she was not satisfied with her *first-year Mathematics module* ***mark*** because the many hostel activities in which she was involved influenced her performance.

Some sections "…I will say integrals because I never did integrals before…" (P1:47) of the *study* ***material*** was *difficult* for the interviewee. "…but when I understood it, I saw it was not so difficult." (P1:47)*.* Extracurricular activities contributed to the fact that she did not spend enough time understanding the difficult parts of the Mathematics material.

Part of the interviewee's **preparation** for the Mathematics module was by doing *revision.* She "…worked through notes and for preparation through the Study Guide…" (P1:31) The interviewee did not ask questions in class because "…some of the time I did not go prepared to the *class*…" (P1:20) To prepare for *tests,* the interviewee "…did not do many exercises. Like, many tests, old tests..." (P1:34)

The interviewee showed **self-efficacy** with her *perseverance with problems* since "…I really want to come up with the correct answer …" (P1:36) and thus "…I work on a problem for an hour, I will leave it and go on with something else, and then I go back to my problem." (P1:36)

The **study environment** of the interviewee could have been a factor, which influenced her academic performance. Her *transition from school to university* was not easy since "… here are also many responsibilities. You have to work hard." (P1:30)

The ***time*** the interviewee spent on *studying* was on average two hours per day in a seven-day week. She spent more time on the Mathematics module because "…I like Mathematics a lot..." (P1:1) During weekends she had to catch up on the work, which she could not do during the week. The interviewee's *time management* was a problem for her. Her reasons for that were that "…I did not have much time to study…" (P1:34) and "…like I wanted to work according to my timetable, but I could not, because, like, there were too many other things also. I could not only concentrate on Mathematics…" (P1:46)

4.3.4.4 [8]Interviewee 2: Average performance

Table 13: Categories and codes used by interviewee 2 and summary of interviewee's responses

Categories	Codes	Summary
Academic help	Lecturer	Pursued help only before tests
	Maths centre	Did not visit centre because of his full timetable
	Peers	Rather seek help from peers who were good in Mathematics
	General	Wanted to attend extra classes for additional help
	Tutor	Helped him in a great way
Classes	Class attendance	Attendance on a regular basis was important
	Class size	Felt uncomfortable with big classes
Lived experience	Experience with Maths	It was a hindrance for him.
	Understanding Maths	He did not really understand the content
Marks	Grade 12	Distinction
	Maths 1st year	He was disappointed because he barely passed
Material	Difficulty of material	Definitions, theorems
Preparation	Revision	Not regular
	Classes	Did not prepare
	Tests	Wanted to study thoroughly for tests
Self-efficacy	Perseverance with problems	Worked at problems until he found the correct answer
Study environment	General info	To be comfortable in class was important for him. It was not easy to ask questions in class
Time	Study time per day	He did not spend time on studying frequently and could have studied more
	Time management	Struggled

[8] Although interviewee 2 answered the questions in Afrikaans, the English translations of the quotes were used in this discussion.

The interviewee stated that he only pursued **academic help** from his *lecturer* "…when I had to write a test or something." (P4:9) and that he did only once or twice. He also mentioned that he could not visit the *Mathematics centre* even though he wanted to since "…it was not in my time schedule." (P4:49) He rather asked his *peers* for academic help and those were "…first-years who studied with us and who I saw were quite good in the Mathematics…" (P4:8) To get academic help in *general*, the interviewee also investigated the possibility to pursue help from someone who gave extra classes in Mathematics, but "…I heard a little too late about someone who gave good class…" (P4:16) The *tutors,* who were available during the weekly tutorial sessions, helped the interviewee in a great way with the problems he had.

Only this interviewee mentioned that ***class*** *attendance* on a regular basis was important to perform well in Mathematics, even though he barely passed the Mathematics module. The interviewee felt uncomfortable with the bigger *class sizes* at university and was not used to it, in comparison with smaller class sizes at school.

The overall **lived experience** the interviewee had with the Mathematics module is explained with his *experience* he had with and the *understanding* of the *Mathematics* module. For him, his experience "…was a stumble." (P4:12) This 'not so good' experience is confirmed with him mentioning that "…I think main reasons are that I do not understand the content. Like really understand it…" (P4:47)

The **marks** the interviewee obtained in *Grade 12* were much better than his *first-year Mathematics* module *mark*. He obtained a distinction in Mathematics in Grade 12 but barely passed his first-year, first semester Mathematics module. Therefore, he was extremely disappointed with his Mathematics module mark, because "…before I came to university, I thought I will get about at least 60 to 70. But, I really thought because I understood Mathematics so well..." (P4:43)

The *difficulty of the* ***material*** influenced the interviewee's performance in the Mathematics module since he said that the Mathematics module "…felt for me more like learning work, more understanding, definitions, theorems and that was difficult for me. So I found it easier to understand than to learn." (P4:5)

Doing *revision* and **preparation** for *classes* and *tests*, the interviewee indicated that he did revision "(Sigh) Hmm…I think now and then…" (P4:35) and "…then like up to a certain part, I worked through it again…" (P4:35) The interviewee indicated that he wanted to prepare for tests "…for a week. Like yes… study thoroughly..." (P4:20) As thorough as he wanted to prepare for tests, he pointed out that he did not prepare for any classes.

Self-efficacy of the interviewee was emphasised by his *perseverance with problems* in the Mathematics module. He highlighted the fact that "…I never gave up. I sit until I get it correct otherwise, it will bother me the whole time. (P4:22)

To be comfortable in class was an important aspect for the interviewee. He asked questions in class to understand the content of the module better, even though some of his peers were irritated with him.

The **study environment** of the interviewee could have had an influence on his performance because he made a *general* comment that he realised "…comfortableness in class…" (P4:46) was an important factor which could have influenced his performance indirectly. It was not easy for him to ask questions in class at university, but "…usually at school, I was the ringleader…" (P4:46)

Initially, the interviewee indicated that he did not spend any ***time*** *per day on studying* Mathematics and that he struggled with *time management* for the Mathematics module. His reason for not spending any time studying Mathematics per day was "...it was difficult for me to adjust to having class from 7:30 until 17:30. I was too tired afterwards, all the hostel activities and such things. I was just too tired to do anything." (P4:1) Later in the interview, he indicated that "...I did sometimes, if I think carefully, especially when I had to learn…" (P4:2) He also realised that he could have spent more time studying Mathematics because "…a person can always put in more time. Because the thing is, you have to try to make time..." (P4:24)

4.3.4.5 Interviewee 5: Poor performance

Table 14: Categories and codes used by interviewee 5 and summary of interviewee's responses

Categories	Codes	Summary
Academic help	Lecturer	Pursued help only when he missed classes
	Maths centre	On average 3 hours per week
	Peers	When he could not ask his lecturer
	General	Wanted to attend additional classes given by senior student, but with his full timetable, it was not possible
Classes	Number of classes	Full timetable
Lived experience	Experience with Maths	Quite difficult because it was much more in depth than usual
	Understanding Maths	Not possible for interviewee
Marks	Grade 12	Distinction
	Maths 1st year	Failed the module
Material	Difficulty of material	Difficult because of lack of self-discipline
Participation	Maths	Did not participate
Preparation	Revision	Working through class work and homework
	Classes	Did not prepare
	Tests	Did prepare by learning the theory off by heart and then applying it in problems
Progress	Discussed with lecturer	When he realised his marks were becoming poorer
Self-efficacy	Perseverance with problems	He did try hard but at a certain point did give up
	Homework	Not regularly
Study	Peers	Sometimes because he preferred to study alone
Study environment	Transition from school to university	Was a bit difficult
Time	Study time per day	Early in the morning and sometimes during weekends
	Time management	Problematic because of full timetable and his Bible study

Although the interviewee pursued **academic help** from his *lecturer*, he asked her help only "... like sometimes if I had to miss class, I go there and ask what did I miss what do I have to know?" (P6:70) On average, the interviewee visited the *Mathematics centre* three hours per week and he did that in his off times on certain days. The interviewee also pursued academic help from his *peers*, when he could not ask his lecturer during her office hours and specifically from a "guy studying Engineering like his staying in the same flat so I used to… he used to help me." (P6:17) For academic help in *general*, the interviewee wanted to pursue help from additional classes given by senior students, "…but I couldn't attend much because of the times." (P6:16)

Because the interviewee studied Engineering, he also had many ***classes*** per day and that could have influenced his performance.

The *experience* the interviewee had with and his *understanding* of *the Mathematics* module represent the overall **lived experience** the interviewee went through with the module. He found that "…it was quite difficult…" (P6:69) and "…it was much more in depth from what you normally do…Like what I'm used to…" (P6:69) Understanding of the Mathematics module was not really possible for the interviewee since he said that "…I think understanding is a bit far-fetched for now. Because the work that you do does not like really make sense to us now since we're first-years." (P6:49-50)

The *Grade 12 Mathematics* ***mark*** and the *first-year*, first semester *Mathematics* module *mark* of the interviewee showed a disparity between the marks. He obtained a distinction in Grade 12 for Mathematics but did not pass the first-year, first semester Mathematics module. The interviewee felt that "…I did put in enough time and effort and my marks weren't that good…" (P6:30), and thus he had to write the second opportunity in an attempt to pass the Mathematics module.

The interviewee felt the lack of self-discipline at university was the reason why he found the *study* ***material*** of the Mathematics module *difficult*. He indicated that "…when you're at home, there's much more discipline, so it's easier, the study, things like that…" (P6:8), but "…then you come to campus… you got a lot of free time on your hands… you don't have to attend class… you can do whatever you want to". (P6:8)

The almost non-**participation** of the interviewee with the *Mathematics* module in general could be the result of the many classes he had per day and thus it influenced his performance in Mathematics indirectly.

Doing *revision* by working through class work and homework, as part of his general **preparation** for the Mathematics module, the interviewee said "…I feel like if you revise the day's class, then you know what's gonna happen in the next class because it all follows." (P6:44) Although the interviewee did revision of the work done in class, the interviewee indicated that "…I don't really prepare for the *class*." (P6:43) His process of preparing for *tests* was explained in detail by the interviewee:

> *Okay. I first like to see what study units it is. Right? And then I'll check what you have to know. I'll mark it like: this theorem I have to know. This proof I have to know. And I first study the proofs off by heart and the theorems off by heart. And then I start applying it in the examples given in the Study Guide and from that I start doing the class works and homeworks and the tutorials. (P6:38)*

The interviewee *discussed* his **progress** *with* his *lecturer* and asked advice from her when he realised that his "…going a bit down on my marks." (P6:29)

The *perseverance with* Mathematics *problems* showed the interviewee's **self-efficacy**, but he admitted that "I do try hard but in certain situations, you can't just keep on trying." (P6:46) During assessments, he left the problem with which he was struggling and did the problems with which he was at ease. Doing *homework* on a regular basis was not part of the interviewee's strategy to understand the study material of the Mathematics module. He indicated that "…I work through class work and homework. If we have homework, I do it. And I think that's good enough." (P6:45)

To **study** with his *peers*, he did "…sometimes yes, but not most of the time…" (P6:57) and thus he preferred to study *alone*.

The *transition from school to university* was also "…a bit difficult." (P6:68) for the interviewee, which was part of his **study environment**.

The best ***time*** for the interviewee to *study per day*, was "…in the morning when I used to wake up. (P6:3) and he also indicated that "…over weekends I don't have much to do, but I used to push on weekends especially on Saturdays." (P6:15), he spent time on studying. *Time management* was also problematic for the interviewee, since "…we didn't have so much of time. But we did have certain times off, like maybe one hour a day from 7:30 to 17:30." (P6:65) Another reason why the interviewee found time management problematic was that "…I didn't have much time because I did my Bible….and I had to practice that every day and I still have to and prayers five times a day." (P6:65)

4.3.4.6 [9]Interviewee 3: Poor performance

Table 15: Categories and codes used by interviewee 3 and summary of interviewee's responses

Categories	Codes	Summary
Academic help	Lecturer	Did not pursue help
	Maths centre	Helped her because she did her homework in the centre.
	Refresher course	Helped her with the content unfamiliar to her
Classes	Number of classes	Full timetable
Lived experience	Experience with Maths	It went well at the beginning of the semester but near the end she was tired and the work became more difficult
	Understanding Maths	She did not really understand the Mathematics content
Marks	Grade 12	Very good
	Maths 1st year	She was not satisfied
Material	Difficulty of material	She struggled with limits.
Participation	Class	She participated in class by working out examples with the lecturer during class

[9] Although interviewee 3 answered the questions in Afrikaans, the English translations of the quotes were used in this discussion.

Categories	Codes	Summary
Preparation	Revision	She did revision in the evening and sometimes during the weekend
	Classes	She tried to do class preparation on a regular basis when she had time.
	Tests	She worked through homework, tutorials, and examples not done in class
Self-efficacy	Perseverance with problems	She tried to do problems but when it took too long, she went on with other problems
Study	Alone	It was better for her to study alone although she studied with others initially
Study environment	Transition from school to university	It was difficult for her
Time	Study time per day	On average 2 hours per day and she also studied on weekends
	Time management	It was easy for her because she socialised less than her peers but still could not pass the module.

The interviewee indicated "…I never made an appointment with her outside class time…" (P2:18), which confirms the fact that she did not pursue **academic help** from her *lecturer*. However, she did go to her lecturer after she had written her first examination paper, which she failed and had to learn for the second opportunity. The *Mathematics centre* "…helped me in a great way…" (P2:3). She did homework in the Mathematics centre, because "…there is always someone to explain to you and you can go on." (P2:3) It benefitted her because she saved time by being in the centre with available help. Attending the *refresher course* at the beginning of the first semester helped the interviewee with the Mathematics module, since the extra Mathematics, which some students had at school, and she did not, was explained again and that helped her at the beginning of the semester.

Just like all the other interviewees, this interviewee indicated that she had many ***classes** per day.*

The **lived experience** the interviewee had with the Mathematics module, manifested firstly, in the initial *experience* the interviewee had *with the Mathematics* module, which was that "…it went well and I thought it is going to be easy." (P2:28) However, she indicated that "…towards the end, you become tired and work less." (P2:28), and thus the work became more difficult for her. Secondly, although the interviewee found some of the content of the module fascinating, she "…did not really master it in the first semester…" (P2:41). Therefore, her not *understanding of the Mathematics* module's content influenced her performance in the Mathematics module.

The interviewee mentioned that her *Grade 12* Mathematics ***mark*** was very good, but that she was not satisfied with her *first-year*, first semester *Mathematics* module mark. Her marks during the semester "…were fine…" (P2:13) and she thought she "…had prepared enough for Mathematics." (P2:13)

Some units of the study ***material*** the interviewee found *difficult.* She said "…limits were for me a little bit, was a strange concept and it took me long to understand it to feel comfortable to do the sums." (P2:5) However, "…the rest was as if you go on from what you have done at school and it was then for me... it became better nearer to the end." (P2:5) The fast pace at the beginning of the semester was overwhelming for her, but as the semester progressed, she found it more manageable.

The interviewee's **participation** in *class* helped her to understand the work the lecturer explained in class. She "…worked it out with her (lecturer)…" (P2:19) and when the lecturer gave the answers, "…then I write it next to the (my) answer to see where I went wrong. That helped me." (P2:19)

Part of the interviewee's **preparation** was "…I do *revision* of the work done during the day, in the evening, and if I did not get time for it during the week, then I do it during the weekend." (P2:39) When she had time, she tried to prepare for *class* on a regular basis, since "…all the notes are on eFundi, so then I will normally try to read through it…" (P2:37) To prepare for *tests*, the interviewee "…worked through the tutorials again of both groups and I worked out those homework questions and all the examples we did not do in class." (P2:9-10) Although she said that she worked continuously during the semester, and did only revision before a test, she did not pass the Mathematics module.

Even though the interviewee did not pass the Mathematics module, her **self-efficacy** was represented in the *perseverance* she showed *with* Mathematics *problems*. She

"…will normally really try, but if I see it is going to take too long, I will go on, so I rather can go on with a few other problems, than getting stuck with one problem. But I try first for a while." (P2:22)

To **study** *alone*, was better for the interviewee because "...I studied more when I study alone." (P2:33) Initially, she worked together with other students, "…and then it did not work out. " (P2:33)

The *transition from school to university* was part of the interviewee's **study environment**, which influenced her performance in Mathematics. It was a big adjustment for her, because, "…the work was much more, and you work on a very faster basis, and in school, they checked many times if your homework were done. " (P2:25) To motivate herself to work, especially when she was tired in the evenings, was difficult for her.

The ***time*** the interviewee spent on *studying per day* was on average two hours. She indicated that "… some days, then I spent nothing on Mathematics, but other days you spend little bit more time. It depends…" (P2:1) She also worked during weekends by "… catching up all the work and do summaries of the work…" (P2:4) In contrast with the other interviewees, this interviewee indicated that it was easy for her to *manage* her *time* for the Mathematics module. The reason for that was, that "…I think I socialised less than the others." (Laughing) (P2:6) Although she indicated that she did not struggle with her time management, she did not pass the Mathematics module.

4.4 Comparison of interviews according to the categories and codes

Refer to the tables in Addendum 2 as a comparison of all the interviews according to the categories and codes. The following is a short summary of noteworthy results that have emerged.

- *Academic help*
    - The majority of the interviewees pursued help from tutors.

  - Most of the interviewees visited the Mathematics centre, including the poor performers.
  - The two good performers were more engaged academically than the other interviewees, where the best performer was the most engaged even though it was difficult for him to pursue help from his lecturer.

- *Classes*
  - All the interviewees said that they had full timetables.
  - Only one average performer attended class regularly and the same interviewee felt uncomfortable with the big classes.

- *Lived experience*
  - The two best performers and interviewee 6 (average performer) had a pleasant experience with the Mathematics module in contrast with interviewee 2 (average performer) and the two poor performers whose experience with the Mathematics module was difficult.
  - Not one of the poor performers indicated that he/she understood the content of the Mathematics module at all, whereas interviewee 1 (good performer) and 6 (average performer) tried to understand the content of this module.

- *Marks*
  - All the interviewees obtained very high Grade 12 Mathematics marks. However, only two of the six interviewees were satisfied with the Mathematics module mark, whereas the other four obtained average or poor module marks. This result will be discussed in more detail under the limitations in Chapter 5. It is necessary to mention that interviewee 4 obtained the highest Grade 12 Mathematics mark and the highest module mark in the WISN111-module.

- *Material*
  - All the interviewees found the Mathematics material difficult, regardless of their Mathematics performance, except interviewee 4, who mentioned that the material was not difficult for him.

- *Participation*
  - Interviewee 4, the best performer, was the only interviewee who asked questions during class time.
- *Preparation*
  - Revision was done by most of the interviewees but with different degrees of intensity.
  - Interviewee 1 (good performer) and 3 (poor performer) tried to prepare for class, whereas interviewee 6 (average performer) and the other poor performer indicated that they did not prepare for class. The interviewee, who actually did prepare for class, even though it was in the beginning of the semester, was interviewee 4, the best performer.
- *Progress*
  - The two good performers and one poor performer (interviewee 5), discussed their academic progress with their lecturer, but in different situations. The other three interviewees did not discuss their progress with their lecturer.
- *Self-efficacy*
  - All the interviewees proved perseverance with Mathematics problems, regardless of their performance. However, only the two good performers did homework on a regular basis and interviewee 5 (poor performer), who failed the module, did homework occasionally.
- *Study*
  - The two poor performers were the only two who mentioned that they preferred to study alone, although they did study with their peers at the beginning of the semester.
- *Study environment*
  - The transition from school to university was difficult for interviewee 6 (average performer), and also for the two poor performers.
  - Interviewee 4 (good performer) mentioned specifically the positive experience he had with the translation services of the university, where the classes were translated from Afrikaans to English.

  - It is, however, necessary to mention that interviewee 1, one of the good performers, was the only interviewee who received home-schooling.

- *Time*
  - Interviewee 4 (good performer) studied the most hours on a daily basis for Mathematics, although the other interviewees also studied daily for Mathematics. However, interviewee 2, who obtained an average Mathematics module mark, did not study often.
  - Time management in the Mathematics module was difficult for all the interviewees, except interviewee 3 (poor performer). Although interviewee 4 (good performer) also struggled with his time management, he still spent the most hours daily on Mathematics.

Viewed independently from the quantitative data, this analysis of the qualitative data with regard to interviewee 4, who not only had the highest Grade 12 Mathematics mark, but also the highest WISN111 module mark, indicates that he was most engaged in terms of various facets of student engagement, and performed very well as a first-year student in the first semester at tertiary level, compared to the profiles of the other interviewees as illustrated in the above analysis. The significance of this specific case will be discussed further in the conclusions in Chapter 5.

4.5 Summary

In this chapter, the results from the quantitative and qualitative research process were reported. Regarding the quantitative research process, the reliability of the data was determined by calculating the Cronbach's Alpha values and confirmatory factor analysis was done to substantiate construct validity of the data. The validity of the research instrument, the questionnaire, was ascertained through content validity procedures. Regarding the qualitative research process, the analysis of all the interviews was reported according to each interviewee's interview and the identified category and code which emerged from each interview.

In the next chapter, discussions and conclusions obtained from the results of the research are discussed. Thus, the relationship between the quantitative and qualitative results will be drawn, and the recommendations and the limitations spawned by the research will be discussed.

CHAPTER 5
DISCUSSION AND CONCLUSIONS

5.1 Introduction

An overview of this study will now be given to guide the discussion of results and subsequent conclusions. Chapter 1 presents the problem statement and the main question that guides this research is as follows:

> **What is the influence of student engagement on the performance of the first-year Mathematics students?**

The introductory chapter also presents the research aims (see 1.2) and furthermore the research design, measuring instruments and data collection, the data analysis, a description of the participants, the quantitative and qualitative approaches to this mixed methods research, as well as the reliability, validity, and the ethical issues (see 1.3).

The literature overview in Chapter 2 gives a broad insight into research done on student engagement and Mathematics performance, and therefore the overview is represented according to the following key aspects:

- Definitions of student engagement (see 2.2);
- Elements of student engagement (see 2.3);
- General factors influencing the performance of students (see 2.4);
- Factors influencing the Mathematics performance of students (see 2.5);
- Student engagement influencing student performance (see 2.6); and
- Student engagement influencing the performance of Mathematics students (see 2.7).

In Chapter 3, the research design and methodology are presented in detail. This chapter discusses the aim of the research, the research design used, the population and participants of this study, what role the researcher played in this study, the data collection methods and data analysis, and also the reliability, validity and the ethics of this study.

In Chapter 4, the results of the quantitative and qualitative data were discussed. For the quantitative results, the following statistical procedures were carried out by the Statistical Consultation Services of the North-West University, Potchefstroom Campus: The construct validity and reliability was discussed (see 4.2.2), which includes the factor analysis and the facets of student engagement with the identified constructs (see 4.2.2.1) and the reliability of the constructs (see 4.2.2.2). Then the descriptive data, which includes the mean and the standard deviation of the constructs (see 4.2.3.1) were determined. The correlations of the constructs with the Mathematics module mark were determined next (see 4.2.4). Lastly, stepwise regression (see 4.2.5.1) was applied to form regression models of the study population, the engineering students and the natural science students to determine the best predictor for each regression model. The process of data analysis for the qualitative results was also discussed in Chapter 4. The categories and codes, which were determined by Atlas.ti., are summarised in Figure 11 (see 4.3.2). The background of each interviewee was given (see 4.3.3) and then each interviewee's interview, which was transcribed and analysed according to identified categories and codes, was discussed (see 4.3.4).

In this chapter, the results of the quantitative and qualitative data analyses are discussed in order to answer the research question of this study. The results and findings of the quantitative and qualitative data analyses are merged and discussed according to the literature.

5.2 Discussions of quantitative and qualitative data

The focus of this study is to determine the influence that student engagement has on the performance of first-year Mathematics students. The discussion is done according to the facets of student engagement as identified from the NSSE, the literature overview from Chapter 2 and the results from Chapter 4 (quantitative and qualitative data).

5.2.1 Level of academic challenge

Construct 1 (Assignments and notes; Q27, Q28, Q33, Q34): A mean value of 2.44 (Table 5, 4.2.3.1) indicates that the participants "sometimes"[10] made notes and summaries of the work explained in the class in Grade 12 and that they did it more "often" in the first-year, first semester Mathematics module (mean value of 2.60, Table 5, 4.2.3.1). According to the regression model of the study population (Table 7, 4.2.5.1), this factor of Construct 1, which appeared only in this regression model, helped to predict the module mark, even though the effect size was small (0.04). There was no correlation between making notes in class and summaries after class in Grade 12 (0.03) (Table 6, 4.2.4) and in the first-year Mathematics module (0.14) (Table 6, 4.2.4) with the module mark. One of the interviewees who performed well indicated that he did revision of the work explained in class on a regular basis. The interviewees, who obtained average marks, said that they did revision of the class notes and summaries to help them understand the work better. Although failing the module, one interviewee said he did revision of the day's work by working through the class work and homework and the other interviewee, who also failed the module, did revision during the day, in the evenings and when necessary, during weekends. Thus, the qualitative data confirmed the quantitative data.

Construct 1 (Numerical info; Q29 - 32): There was no correlation with the module mark, as shown by the values of 0.08 and 0.17 (Table 6, 4.2.4) for Grade 12 and the Mathematics module, respectively. Using numerical information to examine and reach conclusions from their own as well as from their peers' problems, was not done "often" in Grade 12 and in their Mathematics module, according to mean values of 2.37 and 2.38 (Table 5, 4.2.3.1) respectively. However, the use of numerical information in Grade 12 appears only in the regression model of the natural science students with a medium effect size of 0.23 (Table 9, 4.2.5.3). Thus, it indicates that the students' use of numerical information during their last year at high school had an influence on their module mark to some extent.

[10] The phrases in inverted commas are the conductors for the corresponding question in the questionnaire.

Construct 2 (Philosophical views; Q35, Q36): The regression model of the natural science students indicated that their philosophical views at university were a predicator of their module mark, with a large effect size of 0.38 (Table 9, 4.2.5.3). However, the negative sign of the parameter estimate shows that the more often the students evaluated their own views and tried to understand other people's views, the lower their Mathematics module marks tended to be. There was no correlation with the module mark (values of -0.06 and -0.01) (Table 6, 4.2.4) for either the participants' views in Grade 11 and 12 or at university in their first year. The negative signs of the correlation values have the same influence as the negative signs of the parameter estimate, as mentioned above. However, according to the mean value of 2.51 (Table 5, 4.2.3.1), it indicates that the participants did "often" evaluate their own philosophical views or tried to understand someone else's views better.

Construct 6 (Perseverance; Q68, Q69): Laird *et al*. (2008:90) and Kuh (2009:17) (see 2.6.1) found that perseverance is an indicator of academic challenge. There was, however, little indication of a correlation between academic challenge and perseverance according to McClenney *et al.* (2012:4) (see 2.6.1). In this study, the mean value of 2.80 (Table 5, 4.2.3.1) implies that the participants showed "often" perseverance in the Mathematics module, which was confirmed by all the interviewees, regardless of the degree for which they studied and their performances. They finished their work in the Mathematics module regularly in spite of many challenges they encountered and also stayed positive even though they performed poorly. The large effect size of 0.38 (Table 9, 4.2.5.3) in the regression model of the natural science students suggests that perseverance is a predictor for these students' module mark. The two interviewees who studied for a BSc degree mentioned their perseverance with Mathematics problems, which confirms the results from the regression model. In spite of this, the correlation value of 0.18 (Table 6, 4.2.4) indicates that perseverance had no correlation with the Mathematics module mark.

Construct 6 (Engaged motivation; Q64 – Q67): The participants were "sometimes" engaged in motivation, according to the mean value of 2.31 (Table 5, 4.2.3.1). Thus, they did not study "often" when there were other interesting things to do, and also did not participate regularly in discussions about the Mathematics module. According to the literature, Sheard *et al.* (2010:9) (see 2.6.1) found that lecturers are worried about their students' lack of motivation to do their academic work. However, the regression model of the study population indicates that, with a medium effect size of 0.16 (Table 7, 4.2.5.1), staying motivated had an influence on the students' module mark to some extent. This construct also appears in the regression model of the natural science students but with a small effect size of 0.13 (Table 9, 4.2.5.3). Thus, it implies that in combination with other predictors, also with small effect sizes, this construct helped predict the module mark of these students. However, according to the correlation value of 0.10 (Table 6, 4.2.4), there was no correlation between this construct and the module mark.

Construct 7 (Experience difficulty; Q70, Q71, Q73, Q74): Chickering and Gamson (1987:4) (see 2.6.1) found that it is important for students to learn how to manage their time because there is no substitute for time on task. In this study, the learning of the Mathematics course material, their time management of the module and getting academic help in general was a "little bit difficult" for the participants and is indicated by the mean value of 2.29 (Table 5, 4.2.3.1). Confirmation is found when all the interviewees indicated that their experience with the course material was difficult, regardless of their performance. Although the correlation of this construct with the module mark is indicated by the medium value of -0.32 (Table 6, 4.2.4), the negative sign of the parameter estimate of the abovementioned regression model suggests that the more the participants' experience with the course material and their time management was difficult, the lower their module mark tended to be. Grehan *et al*. (2015:22) (see 2.7.1) also found in their research that students experienced difficulty with Mathematics assignments and tutorials. This tendency is confirmed by the regression model of the natural science students where the effect size was small (0.12) (Table 9, 4.2.5.3) and a negative parameter.

Construct 8 (Think, analyse, learn; Q77, Q78, Q80, Q81): This construct's correlation with the module mark is 0.23 (Table 6, 4.2.4), which implies that there is no correlation between this construct and the participants' Mathematics module mark. With a mean value of 3.18 (Table 5, 4.2.3.1) for this construct, it signifies that the participants indicated that their critical and analytical thinking were "good", that they could analyse numerical and statistical information, that they could learn effectively on their own and that their use of computer and information technology was of "good" quality. Although the effect size was small (0.08) (Table 7, 4.2.5.1), this construct was one of the possible predictors of the module mark, in combination with other predictors, also with small effect sizes, according to the regression model of the study population.

Construct 8 (Articulate collaborative; Q75, Q76, Q79): The mean value of 2.97 (Table 5, 4.2.3.1) indicates that the participants revealed that their writing and speaking were clear and effective and that they could also work effectively with others. Although the regression model of the study population (Table 7, 4.2.5.1) indicates a small effect size of 0.07, it implies that this construct, in combination with other predictors, also with small effect sizes, helped to predict the module mark. However, the negative sign of the parameter estimate suggests that the more the students write and speak clearly and effectively in the Mathematics module, the lower their module mark tends to be. There was also no correlation between this construct and the module mark, as indicated by the correlation value of 0.04 (Table 6, 4.2.4).

Q46: The extent Mathematics challenged you to do your best work: The correlation values of 0.14 and 0.26 (Table 6, 4.2.4) for Grade 12 and at university, respectively, indicate that there is no correlation between the extent to which Mathematics challenged the participants to do their best in Mathematics and the Mathematics module mark. The mean value of 2.89 (Table 5, 4.2.3.1) indicates that the participants felt that Mathematics "often" challenged them in Grade 12 to do their best and "very often" at university (Mean value of 3.19, Table 5, 4.2.3.1).

Q48: Number of hours studied per day for Maths in the 7-day week: Research indicates that students spend inadequate time or no time at all on Mathematics outside the classroom and found no significant relationship between time spent on studying and performance (Shearman *et al*, 2012:5) (see 2.6.1). In this study, all the interviewees pointed out that they spent on average two hours per day on studying Mathematics, and some of them also did Mathematics during weekends. However, although the interviewees spent different numbers of hours studying Mathematics this had no significant influence on their respective performances in the module. Therefore, no correlation was found between the number of hours the participants studied for the Mathematics module and their module mark, according to the correlation value of -0.12 (Table 6, 4.2.4). Nevertheless, the mean value of 4.06 (Table 5, 4.2.3.1) implies that the participants spent on average four hours per day on studying Mathematics.

Q50: Number of hours studied for all the modules in the 7-day week: This item appears in the regression model of the engineering students (Table 8, 4.2.5.2). Although the effect size is small (0.06) (Table 8, 4.2.5.2), in combination with other predictors also with small effect sizes, this construct helped to predict the module mark. Although the mean value of 8.27 (Table 5, 4.2.3.1) suggests that the participants indicated that they spent eight hours per day on average studying for all their modules, the correlation value of -0.08 means that there was no correlation between the number of hours the participants studied for all their modules in the first semester and their Mathematics module mark. In contrast with the results of this study, Pace (1990:107) and Kuh (2006:17-18) (see 2.6.1) found that the students' marks were influenced by the number of hours they studied per week. Furthermore, Salamonson *et al.* (2009:128) and Kolari *et al* (2008:492) (see 2.6.1) indicated that time spent on studying was not the only predictor of academic performance. Their research shows that factors, such as learning styles and approaches and prior knowledge can also have an influence on performance.

Q23: Number of written tasks 1 – 5 pages completed in Grade 11, 12 and at university: The mean value of 3.04 (Table 5, 4.2.3.1) for the number of written tasks with a maximum of five pages, implies that the majority of students completed on average, three to five tasks in Grade 11 and 12 and in the Mathematics module one to two, according to the mean value of 2.39 (Table 5, 4.2.3.1). There was no correlation between the number of written tasks of one to five pages and the Mathematics module mark, since the correlation values are 0.02 and 0.11 (Table 6, 4.2.4), respectively for Grade 11 and 12 and the WISN111 module mark.

Q24: *Number of written tasks of more than five pages completed in Grade 11, 12 and at university:* The was no correlation between the number of written tasks with more than five pages and the Mathematics module mark, according to the correlation values are 0.04 and 0.03 (Table 6, 4.2.4), respectively for Grade 11 and 12 and the

WISN111 module mark. The mean value of 2.19 (Table 5, 4.2.3.1) implies that the majority of students completed two to three written tasks on average in Grade 11 and 12 and one to two in the Mathematics module, according to the mean value of 1.58 (Table 5, 4.2.3.1).

Q25: Number of hours preparing for Maths class in Grade 11, 12, and at university: The mean values of 6.94 and 5.92 (Table 5, 4.2.3.1), respectively for Grade 11 and 12 and WISN111, indicate that the participants spent more hours preparing for the Mathematics class in grade 11 and 12 than at university. The interviewees who mentioned that they prepared for class on a regular basis were the interviewees who performed well and one of the interviewees who did not pass the module. However, one of the good performers indicated that he prepared for class, but could not maintain it for the whole semester. Not one of the interviewees who obtained an average mark and the other interviewee, who did not pass, prepared for classes. In both the regression models of the study population and the engineering students, the effect sizes of both were small (0.06 and 0.10) (Table 7, 4.2.5.1 and Table 8, 4.2.5.2). The negative sign of the parameter estimate of both these regression models indicates that the more hours these students spent on preparing for the Mathematics class, the more their module mark had a tendency to be low. The correlation values of -0.13 and -0.08 (Table 6, 4.2.4) for Grade 11 and 12 and preparation in the Mathematics module, indicate that there was no correlation between this item and the module mark.

Grade 12 Mathematics mark

Various researchers made different conclusions about students' Mathematics prior knowledge and therefore their Grade 12 Mathematics marks. Students who took Mathematics on an advanced level at secondary school performed better in first-year Mathematics modules (Evans & Farley, 1984:4; Rylands & Coady, 2009:746; Varsavsky, 2010:1046) (see 2.5.1.2) in comparison with their peers who had not done Mathematics on an advanced level at secondary school. Varsavsky (2010:1047-1048) (see 2.7.1) also found that the level of Mathematics engagement was higher for those students who took Mathematics on an advanced level in senior secondary school. Thus, the expectation exists that those students could further their studies in Mathematics. Murray (2013:157), Parsons *et al.* (2009:65) and Tewari (2014:236) (see 2.5.1.2) suggested that students' Grade 12 Mathematics marks are good predictors of Mathematics performance in first-year Mathematics modules. In this study, the correlation between the participants' Grade 12 Mathematics mark and their WISN111 module mark was 0.68, which indicates a practical significant correlation. This variable appears in all the regression models, as discussed in 4.2.5. The effect sizes for the study population, the engineering students and the natural science students were all large (0.64, 1.02, 0.40), respectively. Thus, the Grade 12 Mathematics mark is a predictor of the Mathematics module mark with a large effect. The interviewees who performed well and average in the first-year Mathematics module, all had Grade 12 Mathematics marks between 70%-97%. Thus, this result confirms the findings from the literature. However, the interviewees who did not pass the first-year Mathematics module also had excellent Grade 12 Mathematics marks, which contradict the findings in the discussed literature. Then again, Kizito *et al.* (2016:113) (see 2.5.1.2) found in their research that there was positive, but weak correlation between Grade 12 Mathematics marks and performance in a first-year Mathematics module.

5.2.2 Active and collaborative learning

Construct 4 (Help from peers with studying; Q51, Q53, Q54): There was no correlation found between this construct and the module mark as seen from the value of 0.07 (Table 6, 4.2.4). Interestingly, this construct appears only in the regression model of the natural science students (Table 9, 4.2.5.3). The medium effect size of 0.15 implies that the help the participants obtained from their peers with their studying had an influence on the student's module mark to some extent. The mean value of 2.57 (Table 5, 4.2.3.1) also confirms that the participants "often" seek help from their peers to understand the Mathematics course material and to explain the course material to them. They also prepared for examinations by discussing or working through the course material with other students on a regular basis and worked "often" on projects, assignments or tutorials with their peers. Patel and Little (2006), Shearman *et al.* (2013) and Solomon *et al.* (2010) (see 2.6.2) all found that the students' Mathematics performance was influenced positively, because of the support they received from their peers. According to Chickering and Gamson

(1987:4) (see 2.6.1), students who generally worked regularly with peers enhanced their learning. However, the negative sign of the parameter estimate in the regression model of the natural science students indicates that the more the participants pursue help from their peers, the lower their module mark tends to be. Those interviewees, who were natural science students, explicitly said that they did not pursue help from their peers, which is in contrast with the results from the regression model of these students. These interviewees' performances were all different. Thus, those interviewees who were engineering students did seek help from their peers, but only one of these three performed well in the Mathematics module.

5.2.3 Supportive campus environment

Construct 9 (Academic support important for the student; Q82, Q83, Q88): It was "very important" for the participants to receive challenging academic experiences, to have support to succeed academically and that there were learning support services available to them. This is indicated by the mean value of 3.20 (Table 5, 4.2.3.1). Although academic support was important for the students, there was no correlation with the Mathematics module mark given that the correlation value was 0.13 (Table 6, 4.2.4).

Construct 9 (Academic support from the university; Q82, Q83, Q88): Kuh (2005:92) and Krause *et al*. (2005:35) (see 2.6.3.1) found that the availability of academic support is an important factor institutions use to enhance student performance in the first year. In this study, the mean value of 3.41 (Table 5, 4.2.3.1) for this construct indicates that the academic support the students needed from the university was fulfilled by the university. The university gave the students a challenging academic experience, the support from the university helped the students to succeed academically, and there were learning support services available to the students. However, there was no correlation between this construct and the module mark, as indicated by the value of 0.005 (Table 6, 4.2.4). This construct appears in both the regression models of the study population and the engineering students with a small effect size of 0.06 (Table 7, 4.2.5.1) for the study population and a medium effect size of 0.18 (Table 8, 4.2.5.2) for the engineering students. The negative signs of the parameter estimates infer that the more academic support the study population and the engineering students received from the university the lower their Mathematics module marks tend to be. According to the literature, NWU (2014:71) (see 2.6.3.3) stated that the Supplemental Instruction (SI) programme at the NWU, Potchefstroom Campus offers a non-remedial style of learning enhancement that improves student retaining and performance. Conversely, Bengesai (2011:59,61) (see 2.6.3.3) indicated that students who attended SI sessions regularly performed well. Harding *et al* (2011:851) (see 2.7.3) also found that the difference in the average Grade 12 marks of the Mathematics students in large Mathematics classes in their first year, who attended at least three SI sessions and those who did not attend any session, was not statistically significant. Four of the six interviewees of this study indicated that they pursued academic help from tutors inside and/or outside class time, regardless of their performance. The two interviewees, who did not pass the module, indicated that they did not pursue academic help from tutors. However, Gasiewski *et al.* (2012:245) (see 2.5.2.3) found that students who spend more time with tutors, had a tendency to be more engaged than their peers who attended tutoring less often, and Patel and Little (2006:133, 136) (see 2.7.2) found that even the struggling students had reacted well with tutoring and that support by either peers or tutors cannot be denied, and had a positive impact on Mathematics performance.

Construct 9 (Non-academic support important for the student; Q84 – Q87): There was no correlation between the non-academic support, which was important for the students and their Mathematics module mark as indicated by the correlation value of -0.06 (Table 6, 4.2.4). The mean value of 2.75 (Table 5, 4.2.3.1) indicates that it was "important" for the participants to be supported by the university in non-academic activities (opportunities to interact with students from different backgrounds; give support to manage their non-academic responsibilities; opportunities to be socially involved; opportunities to attend campus activities and events).

Construct 9 (Non-academic support from university; Q84 – Q87): According to the literature, students from Thomas' (2012:54) (see 2.6.3.2) research recognised the importance of social activities and they were obliged to socialise with other students by being part of organisations and clubs. Matthews *et al.* (2011:115) (see 2.6.3.2) also found that social learning spaces (SLS) can encourage social collaboration between students which may lead to better engagement and that it facilitated the distribution of knowledge to face academic challenges. SLS can also propose an inspiring campus environment and many general fulfilments. In Mathematics, specifically, Solomon *et al.* (2010:430) stated that social learning spaces (SLS) had a major influence on Mathematics students and that it had a great additional effect on the outstanding Mathematics learning support given to students. In this study, however, the correlation between this construct and the module mark is -0.03 (Table 6, 4.2.4), which indicates that there is no correlation. However, the non-academic support given to students was greatly fulfilled by the university according to the mean value of 3.41 (Table 5, 4.2.3.1). Thus, the university did create opportunities for the students to interact with students from different backgrounds and supported the students to manage their non-academic responsibilities. Opportunities were created for the students to be involved socially and also to attend campus activities and events.

Q47: Number of hours spent on additional work for income: There was no correlation between the number of hours students spent on doing additional work for an income and their module mark, according to the correlation value of -0.08 (Table 6, 4.2.4). The mean value of 2.28 (Table 5, 4.2.3.1) suggests that participants spent not more than three hours per week on average on additional work for an income.

Q49: Number of hours per week visiting the Mathematics centre: Several studies in the literature reported on the valuable contributions of Mathematics learning support centres (MLSC) to student engagement and ultimately Mathematics performance (Gordon & Nicholas, 2012; MacGillivray, 2009; Rylands & Shearman 2015; Symonds *et al*., 2008) (see 2.7.3). In this study, this item appears only in the regression model of the study population (Table 7, 4.2.5.1). Regardless of the small effect size of 0.11 (Table 7, 4.2.5.1) in combination with other predictors also with small effect sizes, it helped predict the module mark. The negative sign of the parameter estimate means that the more hours the students visited the Mathematics centre, the lower their Mathematics module marks tend to be, which is in contrast with the literature, as mentioned above. The mean value of 0.96 (Table 5, 4.2.3.1) implies that the participants indicated that on average they did not visit the Mathematics centre for even one hour per week. Two (one good performer and one who nearly passed) of the six interviewees indicated that they did not visit the Mathematics centre because of their full timetables and if they wanted to go, there were too many students in the centre. Two interviewees visited the Mathematics centre, but not on a regular basis, and one interviewee who performed well and one who did not pass visited the Mathematics centre on a regular basis. One of the interviewees who failed the Mathematics module visited the centre only when she had homework to do. Thus, the conclusion can be made that there is no correlation between the number of hours the students visited the Mathematics centre and their Mathematics module mark and it is confirmed by the correlation value of -0.13 (Table 6, 4.2.4).

5.2.4 Enriching educational experience

Construct 3 (Clubs at high school and university; Q38 – Q43, Q45): There is no correlation between the students' involvement with clubs at high school and university and their Mathematics module mark, as seen from the correlation values of -0.11 and 0.01 (Table 6, 4.2.4), respectively. The research done by Pace (1990:110) and Umbach and Wawrzynski (2005:168) (see 2.6.4.3), found that students who spent more hours on non-academic activities, such as athletic and sport activities, participating in clubs and residence activities, may possibly spend the minimum amount of hours on academic activities. However, the mean values of 2.21 and 1.56 (Table 5, 4.2.3.1) for involvement with clubs at high school and university, implies that the students of this study were "almost never" involved in cultural activities, sports teams, learner councils, publications, academic clubs or subject societies, religious youth groups and community service at high school and at university in their first year. One of the natural science students who obtained an average module mark said that the many hostel activities in which she participated had an influence on her Mathematics performance.

Construct 3 (Chess at high school and university; Q44): The participants indicated that they were "almost never" involved with chess at high school and at university, according to the mean values of 1.54 and 1.11 (Table 5, 4.2.3.1). The item *"Chess at high school"* appears in the regression models of the natural science and engineering students. The small effect size of 0.09 (Table 8, 4.2.5.2) in the regression model of the engineering students implies that, although the effect size is small on its own, in combination with other predictors also with small effect sizes, this construct helped to predict the Mathematics module mark. However, the negative sign of the parameter estimate indicates that the more the engineering students were involved in chess at high school, the lower their Mathematics module marks tend to be. Interestingly, the effect size of the item *"Chess at high school"* for the natural science students has a medium value of 0.34 (Table 9, 4.2.5.3). Thus, being involved in chess at high school had an influence on these students' module mark to some extent. The positive sign of the parameter estimate, in contrast with the negative sign of the parameter estimate at the regression model of the engineering students, implies that the more the natural science students were involved with chess at high school, the higher their Mathematics module mark tends to be. The correlation values between chess at high school and university and the Mathematics module mark are -0.03 and -0.02 (Table 6, 4.2.4) respectively. Thus, there is no correlation between this item and the Mathematics module mark.

Construct 5 (Discussions with different groups; Q58 – Q63): The mean value of 2.13 (Table 5, 4.2.3.1) suggests that the participants "sometimes" had discussions with people of a different race, economic background, with other religious and/or political views and with other sexual orientations than their own or with people with disabilities. There is no correlation between this construct and the Mathematics module mark, given the correlation value of -0.17 (Table 6, 4.2.4). Because of the small effect size of 0.03 (Table 7, 4.2.5.1), which this construct has in the regression model of the study population, it implies that, although small in size on its own, in combination with other predictors also with small effect sizes, this construct helped to predict the Mathematics module mark. The influence of the negative sign of the parameter estimate is the same as mentioned above about the negative sign of the correlation value. Interestingly, in the regression model for the engineering students, this construct has a medium effect size of 0.19 (Table 8, 4.2.5.2), which indicates that having discussions with people from different groups, had an influence on these students' Mathematics module mark to some extent. The parameter estimate of this regression model also has a negative sign and therefore also means that the more the participants had discussions with people of different groups, the lower their module mark tends to be.

Q26: Number of hours spent on extracurricular activities in 7-day week in grade 11, 12 and at university: The correlation values of 0.06 and 0.05 (Table 6, 4.2.4) for the number of hours spent on extracurricular activities in Grade 11 and 12 and at university, indicate that there is no correlation between this item and the participants' Mathematics module mark. From the mean values of 8.60 (Table 5, 4.2.3.1) and 5.97 (Table 5, 4.2.3.1) respectively for Grade 11 and 12 and at university, it seems that the participants spent more time on extra-curricular activities in Grade 11 and 12 than at university.

Q37: Number of hours in a 7-day week relaxing and socialising: This item had no correlation with the Mathematics module mark, according to the correlation values of -0.03 and -0.06 (Table 6, 4.2.4) for Grade 12 and at university. In spite of the fact that there was no correlation, the mean values of 16.88 and 12.60 (Table 5, 4.2.3.1) suggest that the participants spent many hours per week on relaxing and socialising and that the amount of hours decreased from Grade 12 to university.

Q18: Number of extra modules, not part of programme/degree registered this year: The mean value of 0.19 (Table 5, 4.2.3.1) implies that on average the participants did not register for even one extra module in their first year. There was no correlation between this construct and the Mathematics module mark of the participants, given the correlation value of -0.08 (Table 6, 4.2.4).

5.2.5 Student-staff interaction

Construct 4 (Discussions with lecturer; Q55 – Q56): Thompson (2001:45) (see 2.7.5) found that there was a meaningful correlation between the informal student-lecturer interactions and the students' mathematical performances and interaction between student and lecturer can be via various means of communication, such as face-to-face talks, discussions and e-mail (Froyd, 2008:14) (see 2.7.5). However, in this study, the correlation value of 0.04 (Table 6, 4.2.4) indicates that there is no correlation between the discussions the participants had with their lecturers and their Mathematics module mark. Also found in this study, is the mean value of 1.24 (Table 5, 4.2.3.1), which implies that the participants "almost never" talked with their lecturers about their career plans, their academic progress, or approached a lecturer to assist them with the Mathematics module outside the classroom. One of the interviewees, who performed well in the Mathematics module, indicated that she pursued help from her lecturer almost daily and discussed her progress regularly with her lecturer. The other good performer found it difficult to seek help from his lecturer outside class time, not because he did not want to, but because the lecturer was not always available. However, he discussed his progress with his lecturer after almost each tutorial. Interviewee 6, who obtained an average mark, did not ask for help from her lecturer outside class time since she stayed too far from the lecturer's office. Therefore, she did not discuss her progress with her lecturer either. Interviewee 2 only pursued help from his lecturer before a test and did not discuss his progress with his lecturer. Asking help from his lecturer only when he missed a class and discussed his progress when he realised his marks went down, could have had an influence on the poor Mathematics module mark of one of the interviewees. The other interviewee who performed poorly did not pursue help from her lecturer, and thus also did not discuss her progress with her lecturer. Although the mean value indicates that students in general do not ask for help from their lecturers, the interviews indicated that if they do, it influences their performance in the Mathematics module positively and *vice versa*.

5.3 Items not resorted under facets of student engagement

The following items are of a biographical nature and are included in this discussion since they also impact on performance in Mathematics even though they are not part of the facets of student engagement. However, the researcher is inclined to interpret the listed aspects below as important biographical details of a student's profile in general, and indices, which influence the nature of how a student will engage in his/her studies at tertiary level.

5.3.1 Loans (Q90)

In the regression model of the study population, the item *"Loans"* appears with a small effect size of 0.04 (Table 7, 4.2.5.1). It indicates that, in combination with other predictors also with small effect sizes, this construct helped predict the module mark. The mean value of 2.75 (Table 5, 4.2.3.1) suggests that the participants "partially" made use of loans.

5.3.2 Expenses (Q72)

To pay for university expenses was a "little bit difficult" for the participants, according to the mean value of 2.04 (Table 5, 4.2.3.1). The correlation value of -0.10 (Table 6, 4.2.4) indicates that there was no correlation between the expenses the participants had and their Mathematics module mark.

5.3.3 Gender (Q2)

In the literature, it was found that female students performed better in Mathematics than their male peers (Afan & Othman, 2005:340; Eng *et al.,* 2010:140 and Moreno & Muller, 1999:41) (see 2.5.3). However, Anthony (2000:9) (see 2.5.3) found no statistical meaningful difference between the gender of students and their Mathematics performance. This item appears only in the regression model of the natural science students and has a small effect size of 0.12 (Table 9, 4.2.5.3).Thus, the female natural science students performed better in Mathematics than their male peers. Although small in size on its own, in combination with other predictors, also with small effect sizes, *"gender"* helped predict the module mark. It is interesting to note that *"gender"* did not appear in the other two regression models.

5.3.4 The highest level of education completed by father/paternal guide and mother/maternal guide (Q15 and Q16)

Because the literature does not differentiate between the level of education of the father and mother of students, Items 15 and 16 of the questionnaire will be discussed together, even though these two items appeared separately in this study.

Allen *et al.*, (2008:661) and Ali *et al.*, (2009:86) (see 2.4.3.2) found in their research that the higher the socio-economic (educational level and income) status of the parents were, the better the students' first-year average marks tended to be. However, the research of Keeve *et al*., (2012:48) (see 2.4.3.2) indicated that students whose parents had no higher education performed better at tertiary level. In this study, the mean value of 6.55 (Table 5, 4.2.3.1) for the highest level of education of the father, suggests that the participants indicated that, on average, their father's highest level of education, was either a Technikon/FET college qualification or a

Bachelor's degree. For their mothers' highest education, the mean value of 6.17 (Table 5, 4.2.3.1) indicates that on average the participants' mothers' highest education was a Technikon/FET college qualification. With a correlation value of 0.08 (Table 6, 4.2.4), the highest level of education completed by the students' father or paternal guardian in this study, had no correlation with their Mathematics module marks. This construct appears in the regression models of the engineering and natural science students, with small effect sizes, of 0.12 and 0.11 (Table 8, 4.2.5.2 and Table 9, 4.2.5.3) each. The negative sign of the parameter estimate in the regression model of the natural science students indicates that the higher their fathers' level of education was, the lower their module mark tends to be, which is in contrast with the positive parameter estimate in the engineering students' regression model. The item *"Highest level of education by mother or maternal guide*" appears only in the regression model of the engineering students. The small effect size of 0.10 (Table 8, 4.2.5.2) indicates that in combination with other predictors, also with small effect sizes, this item helped predict these students' module mark. The negative sign of the parameter estimate indicates that the higher the level of education of the students' mother was, the lower their module mark tends to be. However, the item's correlation value of 0.07 (Table 6, 4.2.4) indicates that there was no correlation with the Mathematics module mark.

5.4 Conclusions

The results found in this study are often interesting, and, one might argue, not as expected. For this reason, the researcher will be speculative regarding certain sections of the conclusions. The conclusions will be given according to the facets of student engagement, which is the same way in which the discussions were done.

5.4.1 Level of academic challenge

Assignments and notes

Although there was no correlation with making notes in class, revision after class and doing assignments, and the Mathematics module mark, the participants indicated that they did revision regularly and this is confirmed by the majority of the interviewees, regardless of their performance in the Mathematics module. Thus, to make notes in class and revise the work on a regular basis, can have an influence on students' Mathematics performance.

Numerical info

By using numerical information in Grade 12 to examine and draw conclusions from problems, helped to predict the module mark of only the natural science participants. The participants indicated that they did not "often" use the numerical information and thus by doing so, did not influence their performance in the Mathematics module at university.

Philosophical views

Although the evaluation of their own philosophical views and trying to understand their peers' views better were a good predictor of the natural science participants' module mark, it was found that the more they evaluated views, the lower their module mark tends to be. Therefore, the natural science participants might have spent too much time on evaluating views and not enough time on studying.

Perseverance

From the results of the questionnaire, it is evident that the participants showed perseverance when doing Mathematics problems, and especially the natural science students. Although the literature contradicts this outcome, the interviewees who studied BSc degrees, verify the results. A reason why the results did not indicate that the engineering students persevered as often as the natural science students can be that the engineering students had a timetable with more classes per week and did not have as much time to do problems as the natural science students.

Engaged motivation

The lack of motivation by students to do academic work, as found in the literature, was also found in this study's results. The participants were not eager to study when there were more interesting things to do and showed a lack of engagement in discussions about the Mathematics module. Although this construct was a predictor of the module mark of the study population to some extent, it was a small predictor of the Mathematics module mark of the natural science students.

Experience difficulty

The majority of the participants experienced difficulty with the Mathematics course material and their time management. This is confirmed by the literature, as well as the interviewees, regardless of their performance in the Mathematics module. Thus, the fact that they struggled with the content of the module did not guarantee that they performed well in the Mathematics module. It implies that the more difficult they found the course material, the lower their module marks tend to be. Thus, the content of the Mathematics module was on such a difficult level, that some of the students failed the module, even though they worked hard.

Think, analyse, learn

Although there was no correlation between this construct and the module mark, the participants' perceptions about their critical and analytical thinking were that their thinking was good and that they could learn effectively on their own. However, this construct does not necessarily have a major influence on the Mathematics performance of the students.

Articulate collaborative

Because of the low correlation with the module mark, the conclusion can be drawn that to write and speak clearly and effectively, may not have influenced the participants' Mathematics module mark.

Challenge to do your best

Although the participants indicated that Mathematics challenged them to some extent, there was no correlation with the Mathematics module mark and thus no influence on their performance.

Number of hours studied

The contradiction found in the literature about the influence of the time spent on studying outside the classroom was also found in this study. The interviewees confirmed that, even though they spent on average the same number of hours studying Mathematics their performances in the Mathematics module, were all different. Furthermore, confirmation was found with the low correlation of study time and the Mathematics module mark. Thus, it appears as if the number of hours the students spend on studying Mathematics did not have an influence on the Mathematics performance of the students.

Number of hours studied for all their modules.

Although the literature indicated that students' performances were influenced by the number of hours they studied, it is in contrast with this study's results. The fact that the engineering students had many modules and a full timetable could have influenced their Mathematics module mark negatively. They also had to spend time on their other modules, and thus, did not spend adequate time on the Mathematics module to perform well. However, the literature also indicated that the time spent on studying cannot be the only predictor of performance. It will be better to look at a combination of factors to determine the true influence on Mathematics performance.

Written tasks 1 – 5 pages

Since no correlation was found between this item and the Mathematics module mark and the fact that the mean values indicated that the participants did not complete many written tasks, the conclusion can be made that the number of written tasks completed by the participants, did not influence their performance.

Written tasks more than 5 pages

The number of completed written tasks with more than five pages did not influence the participants' performance since there was no correlation between this item and the Mathematics module mark and this is also confirmed by the mean values.

Preparing for Maths class

Preparation for the Mathematics class had no convincing influence on the module mark of the study population and the engineering students. However, the interviewees indicated that to prepare or not for class, did not guarantee good performance in Mathematics. The results indicate that the more hours the engineering and study population spent on preparing for the Mathematics class, the lower their Mathematics marks tended to be.

Grade 12 Mathematics mark

It is clear from the literature and the results from this study that the Grade 12 Mathematics mark is the best predictor for the first-year Mathematics module mark. Although some of the interviewees' Mathematics module marks were in contrast with the findings in the literature and the correlation value with the Mathematics module mark, it can still be concluded that the Grade 12 Mathematics mark predicts the Mathematics module mark, since the study population is not well presented by the selected interviewees.

5.4.2 Active and collaborative learning

Help from peers

According to the literature, pursuing help from peers influenced students' Mathematics performance positively. However, the results regarding the natural science students showed that, even though this construct had to some extent a practical influence on these students' module mark, the natural science interviewees indicated that they did not seek help from their peers, which is in contrast with what was stated in the literature. The fact that the negative sign of the parameter estimate in the regression model of these students implies that the more the natural science students pursued help from their peers, the lower their module mark tends to be, is also in contrast with what the interviewees said. Although the interviewees who studied Engineering indicated that they pursued help from their peers, only one of them performed well in the Mathematics module.

5.4.3 Supportive environment

Academic support important for student

It was important for the students to receive academic support from the university, but it did not influence their module mark.

Academic support from university

The results of this study indicate that the university provided the academic support that students need. By pursuing help from tutors, the majority of the interviewees obtained average or good marks for their Mathematics module. These results are confirmed by the literature. Thus, the fact that the interviewees who failed the Mathematics module did not seek help from tutors, also confirms what was found in the literature. As discussed in 5.2.3 and deduced from the regression models of the engineering students and study population, it was concluded that the more these students made use of academic support, the lower their module marks tend to be. This can indicate that, at this stage, the weaker students of the study population need more academic help and did use the academic support, which the university offered. Thus, they showed engagement with the Mathematics module which is a positive feature. Furthermore, it can be concluded that the stronger engineering students did not need as much academic support from the university as their fellow students.

Non-academic support important for student

It was important for the students to receive non-academic support from the university, but it did not influence the Mathematics performance of the participants.

Non-academic support from university

The university supported students in a non-academic way according to the results of this study, but there was no correlation between this construct and the module mark. Thus, the results of this study are in contrast with what was found in the literature, which is that SLS (social learning spaces) can encourage engagement and thus better performance.

Hours spend on additional work for an income

There was no correlation between the number of hours spent on additional work for an income and the participants' Mathematics performance.

Mathematics centre

No clear conclusion can be drawn about the help the students received in the Mathematics centre. It appears as if the more hours the students visited the centre, the lower their marks tended to be, which is in contrast with what the literature indicated. Thus, the help the participants received in the centre was not significant enough to perform well in the Mathematics module. From the interviews, these results were confirmed. The performances of the interviewees, whether it was good or bad, were not influenced by the number of hours they visited the Mathematics centre.

5.4.4 Enriching educational experience

Clubs in high school and university

The participants indicated that they were "almost never" involved in clubs at university, and since only a few participants indicated that they were involved in clubs, no conclusion can be made about the influence the students' involvement in clubs had on their Mathematics performance.

Chess at high school and university

The NSSE did not include enquiries about the participation in chess at high school and at university level. However, the researcher decided to include this extra-curricular activity in the questionnaire out of interest for what the outcome would be. It would seem that the participation in chess in high school affected only the performance of the natural science participants in a positive way to some extent. To argue for a correlation between chess and Mathematics performance, a more in-depth study is necessary.

Discussions with different groups

Because of the discussions the participants had with people of different groups from time to time, they did not have enough time to study, and thus, their Mathematics module mark was influenced negatively. This is confirmed by the regression models of the study population and engineering students. Although this construct had an influence on the module marks of the engineering students to some extent, the model indicates that the more discussions these students had with different groups, the lower their module marks tend to be.

Hours spend on extra-curricular activities

There is no indication that the number of hours the participants spent on extra-curricular activities influenced their Mathematics performance, even though it appears that the participants spent eight hours per week on average on extracurricular activities.

Hours relaxing/socialising

Even though the participants indicated that they spent on average almost 13 hours per week on relaxing/socialising, no correlation was found between this item and the Mathematics module mark, and thus, there is no indication that it influenced the participants' Mathematics performance.

Number of extra modules registered for

No indication was found regarding the influence the number of extra modules the participants were registered for, had on their Mathematics performance because the students did not really register for additional modules.

5.4.5 Student-staff interaction

Discussions with lecturers

According to the literature, there is a correlation between the student-staff interaction and Mathematics performance. However, it was found in this study that the participants "almost never" talked to their lecturers about career plans, academic progress or asked for help with the Mathematics module outside the classroom from their lecturers. Only 50% of the interviewees pursued help or discussed their academic progress with their lecturers and those who did, did it under different circumstances, and thus, these results emphasise the quantitative results. Therefore, there is no indication that discussions with lecturers did influence the Mathematics performance of the participants.

5.4.6 Items not part of the facets of student engagement

Even though the following items are not part of the facets of student engagement, the researcher felt that it was also important to draw conclusions about these items.

Loans

To study with a loan did not have any influence on the Mathematics performance of the study population in this study.

Expenses

Although it was “a little bit difficult” for the participants to pay their expenses there is no indication that it had a significant influence on the Mathematics performance of the participants.

Gender

Even though the literature found contradictory results about the influence of students’ gender on their performance at tertiary level, this study’s results revealed that the gender of the natural science students helped predict their Mathematics module mark, in combination with other predictors in the regression model, also with small effect sizes, and that the females students performed better in Mathematics than their male peers.

The highest level of education completed by father/paternal guide or mother/maternal guide

The influence of the parents’ level of education on the students’ Mathematics performance was contradictory to that in the literature. This study found that the level of education of the parents (father and mother) of the engineering students was a predictor of the students’ Mathematics performance, but with a small effect. Only the highest level of education of the father of the natural science students was a predictor of their Mathematics performance, but also with a small effect. Thus, according to this study, it does not matter what the highest level of education of the students’ parents is, it does not influence the students’ Mathematics performance in their first-year in the first semester.

5.5 Summary of conclusions

The most significant outcomes of this study, in terms of student engagement and how it impacts on Mathematics performance in the first year at tertiary level can be summarised as follows:

- The Grade 12 Mathematics mark (prior knowledge) was the most noteworthy predictor for the Mathematics first-year module mark. However, the average Grade 12 mark should be taken into consideration together with the Mathematics mark to obtain a clearer picture of the student's possible performance in the WISN111-module. The reasoning for this conclusion is because the average Grade 12 mark is the second most prominent predictor of the Mathematics first-year module mark.
- Revision of class notes and assignments (part of the facet of student engagement – *level of academic challenge*), influences Mathematics performance. However, no clear conclusion can be made about the influence of class preparation on Mathematics performance.
- In general, it appears as if perseverance (part of the facet of student engagement – *level of academic challenge*) to solve Mathematics problems had an influence on Mathematics performance, even though the interviewees who performed poorly also persevered with problems.
- The participants experienced the content of the Mathematics module as difficult. One average and two poor performers from the interviewees found the content really difficult and limited their level of understanding, despite their perseverance. Thus, they are not ready for the challenges which the Mathematics module expects from them, and therefore their engagement with the WISN111 module is compromised.
- The number of hours studied for the Mathematics module (part of the facet of student engagement – *level of academic challenge*), did not have a significant effect on Mathematics performance, primarily since time management appears to be a challenge in this regard.

- Academic help from tutors (part of the facet of student engagement – *supportive campus environment*) appears to be fairly significant to enhance Mathematics performance since students would rather pursue help from tutors with whom they feel more comfortable in comparison with asking help from lecturers (facet of student engagement – *student-staff interaction*) and their peers (facet of student engagement – *active and collaborative learning*).
- Students who do not spend an adequate amount of time studying because they are involved in too many social activities, the non-academic support from the university, (part of the facet of student engagement – *supportive environment*), tend to have lower Mathematics module marks since there was no correlation between the amount of time studying and the module marks.
- Visiting the Mathematics centre as academic support from the university (part of the third facet of student engagement – *supportive environment*) had no significant influence on the participants' Mathematics performance. The help they received in the centre was maybe not effective enough to assure Mathematics performance.

Figure 12 is an illustration of the facets of student engagements, which were mentioned in 5.5. Figure 12 shows that the most significant outcomes of this study were part of the level of academic challenge as compared to the other facets mentioned. One of the facets of student engagement, "*Enriching educational experiences*", did not appear in the abovementioned discussion, since no significant results were found at this facet.

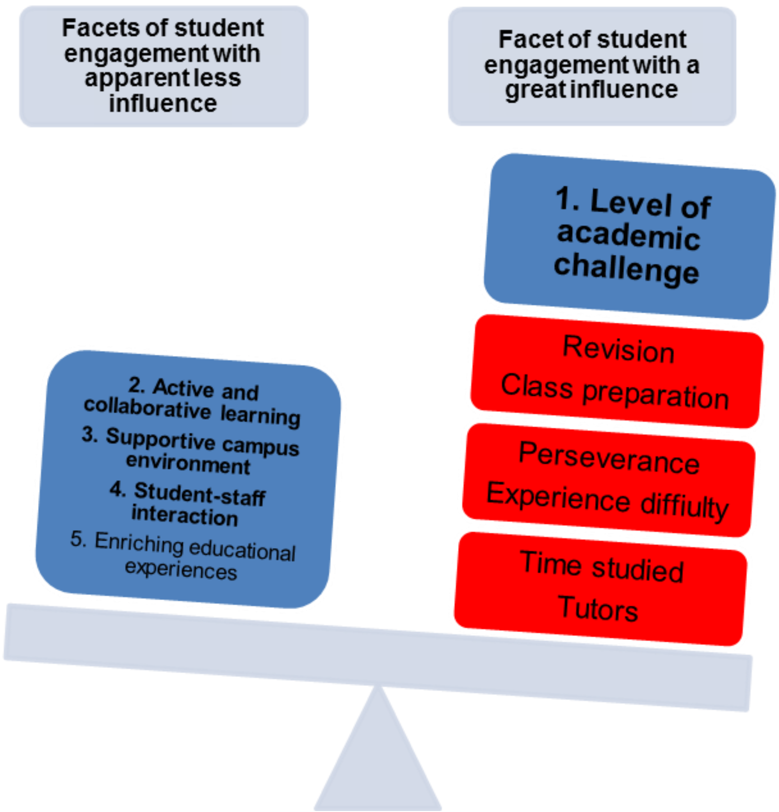

Figure 12: Conclusive hierarchical view of the five facets of student engagement

5.6 Limitations

Viewing this study holistically, the researcher has become conscious of the complexity of mixed methods research, and as a causality the resultant limitations of this research are listed below in terms of the inadequacies regarding the quantitative and qualitative methods that were applied.

- Despite the pilot study and subsequent revision of the adapted NSSE, some of the students still misunderstood a few questions.
- A more diverse and bigger response to participate in this study would have been ideal, given the available study population of 712 Mathematics students.

- However, the researcher is aware that although the interviews supplied meaningful data, additional participants should have been selected for more in-depth interviews, adding more open-ended questions where necessary.
- Taking more care in identifying interviewees is important. The selected six interviewees for this study all obtained a distinction for Grade 12 Mathematics. However, during this selection process of the interviewees, the researcher was not aware that the Grade 12 Mathematics mark is the most significant predictor for the first-year Mathematics module. The selection was made according to the first semester Mathematics module mark, without consideration of the Grade 12 Mathematics mark. Therefore, additional interviewees who obtained much lower Grade 12 Mathematics marks (60%-69%) should have also been selected.

5.7 Recommendations

The following recommendations are proposed for further and future research on the influence of student engagement on the performance of first-year Mathematics students:

- Conducting a longitudinal study over three to four years with a bigger group of first-year Mathematics students and during both semesters, to determine whether additional factors also have a significant correlation with the first-year Mathematics module mark.
- A more in-depth qualitative study with additional in-depth interviews by identifying a bigger and diverse group of interviewees can be performed to ensure qualitative data collection, which subsequently can lead to even more conclusive results.

5.8 Final remark

The research problem of this dissertation concerns how student engagement influences the performance of first-year Mathematics students in their first semester. *Level of academic challenge* emerged as the most prominent facet of student engagement. This is meaningful in the realm of Mathematics education at tertiary level in general, but also more specifically for the following reasons: The challenge that the WISN111 module poses to the student is complex on many levels. Mathematics is per definition academically challenging (the current situation in our country regarding Mathematics education is undeniable). This study illustrates that this complexity directly impacts the students' engagement with Mathematics on a multitude of levels and this further impacts greatly on the other four facets of student engagement and ultimately on the student's overall performance in Mathematics.

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ANNEXURES

ADDENDUM 1: VRAELYS: EERSTEJAARSTUDENTE BETROKKENHEID

QUESTIONNAIRE: FIRST YEAR STUDENT ENGAGEMENT

Vraelys: Eerstejaarstudente betrokkenheid
Questionnaire: First year student engagement

AFDELING A: BIOGRAFIESE INLIGTING (Merk met 'n X)
SECTION A: BIOGRAPHICAL INFORMATION (Mark with an X)

1. Studentenommer / *Student number*

2. Geslag / *Gender*

Manlik / *Male*	1
Vroulik / *Female*	2

3. In watter groep is u vir WISN111? / *In which group are you for WISN111*?

Groep/*Group*	Dosent / *Lecturer*	
a	Dr Hitge	1
b	Mnr/Mr Zeekoei	2
c	Mev/Mrs Rothman	3
d	Mev/Mrs Weyer	4
e	Dr Hitge	5
f	Dr Venter	6

4. Die aantal kere waarvoor u ingeskryf het vir WISN111 (1 indien dit u eerste keer is)
The number of times which you have enrolled for WISN111 (1 if it is your first time)

5. Ouderdom / *Age*

6. Huistaal / *Home language*

Afrikaans	1
English	2
IsiNdebele	3
IsiXhosa	4
IsiZulu	5
Sepedi	6
Sesotho	7
Setswana	8
SiSwati	9
Tsivenda	10
Xitsonga	11
Ander / Other	12

7. Vaardigheid in Afrikaans / *Proficiency in Afrikaans*

Uitstekend / *Excellent*	1
Goed / *Good*	2
Redelik / *Fairly*	3
Swak / *Bad*	4

1

8. Vaardigheid in Engels / *Proficiency in English*

Uitstekend / *Excellent*	1
Goed / *Good*	2
Redelik/ *Fairly*	3
Swak / *Bad*	4

9. Vir watter studierigting/graad is u in 2015 ingskryf?
In 2015, for which study programme/degree are you enrolled?

B.Sc.	1
B.Ing.	2
BWI/BMI	3
B.Com.	4
B.A.	5
Ander / *Other*	6

10. Is u 'n buitelandse student? / *Are you a student from abroad*?

Ja / *Yes*	1
Nee / *No*	2

11. Watter van die volgende beskryf die beste waar u op die oomblik woon?
Which of the following best describes where you are living at the moment?

Koshuis of ander op-kampusakkommodasie / *Dormitory or other on-campus housing*	1
Huis/woonstel binne loopafstand van die kampus (nie ouerhuis) *House/apartment within walking distance from the campus (not parents' house)*	2
Huis/woonstel verder as loopafstand van die kampus (nie ouerhuis) *House/apartment farther than walking distance from campus (not parents' house)*	3
Ouerhuis / *Parents' house*	4
Ander / *Other*	5

12. Het u 'n sportbeurs ontvang om te studeer?
Did you receive a sport bursary to study?

Ja / *Yes*	1
Nee / *No*	2

13. Is u met enige gestremdheid of verswakking gediagnoseer?
Have you been diagnosed with any disability or impairment?

Ja / *Yes*	1
Nee / *No*	2
Ek verkies om nie te antwoord nie *I prefer not to respond*	3

Indien u **JA** by vraag 13 geantwoord het, voltooi vraag 14.
*If you answered **YES** to question 13, answer question 14.*

14. Watter van die volgende is by u gediagnoseer? (Selekteer almal van toepassing.)
Which of the following has been diagnosed with you? (Select all that apply.)

	Ja/*Yes*	Nee/*No*
'n Sensoriese verswakking (sig of gehoor) / *A sensory impairment (vision or hearing)*	1	2
'n Bewegingsverswakking / *A mobility impairment*	1	2
'n Leergebrek (bv. ADHD, disleksie) / *A learning disability (e.g. ADHD, dyslexia)*	1	2
'n Geestesgesondheidsgebrek / *A mental health disorder*	1	2
'n Gebrek of verswakking nie hierbo gelys nie / *A disability or impairment not listed above*	1	2

15. Wat is die hoogste vlak van opleiding wat deur u **pa of manlike voog** voltooi is?
*What is the highest level of education completed by your **father or paternal guide**?*

Geen skoolopleiding / *No schooling*	1
Laerskool / *Primary school*	2
Hoërskool Graad 10 / *High school Grade 10*	3
Hoërskool Graad 12 / *High school Grade 12*	4
Het universiteit/kollege bygewoon, maar nie kwalifikasie voltooi nie / *Attended university/college but did not complete qualification*	5
Technikon / VOO-kollege / *Technikon / FET college*	6
Baccalareusgraad (BA; BSc; ens.) / *Bachelor's degree (BA; BSc; etc.)*	7
Honneursgraad (BA Honns; B.Sc. Honns; ens.) / *Honour's degree (BA Honns; B.Sc. Honns etc.)*	8
Meestersgraad (MA; MSc; ens.) / *Master's degree (MA; MSc; etc.)*	9
Doktors- of professionele graad (PhD, MD; ens.) / *Doctoral or professional degree (PhD; MD; etc.)*	10

16. Wat is die hoogste vlak van opleiding wat deur u **ma of vroulike voog** voltooi is?
*What is the highest level of education completed by your **mother of maternal guide**?*

Geen skoolopleiding / *No schooling*	1
Laerskool / *Primary school*	2
Hoërskool Graad 10 / *High school Grade 10*	3
Hoërskool Graad 12 / *High school Grade 12*	4
Het universiteit/kollege bygewoon, maar nie kwalifikasie voltooi nie / *Attended university/college but did not complete qualification*	5
Technikon / VOO-kollege / *Technikon / FET college*	6
Baccalareusgraad (BA; BSc; ens.) / *Bachelor's degree (BA; BSc; etc.)*	7
Honneursgraad (BA Honns; B.Sc. Honns; ens.) / *Honour's degree (BA Honns; B.Sc. Honns etc.)*	
Meestersgraad (MA; MSc; ens.) / *Master's degree (MA; MSc; etc.)*	8
Doktors- of professionele graad (PhD, MD; ens.) / *Doctoral or professional degree (PhD; MD; etc.)*	9

17. Vir hoeveel modules is u hierdie jaar (eerste en tweede semester) geregistreer?
For how many modules are you registered this year (first and second semester)?

3

18. Vir hoeveel ekstra modules wat nie deel van u program/graad is nie, is u hierdie jaar geregistreer?
For how many extra modules which are not part of your programme/degree, are your registered this year?

AFDELING B: DIE VRAELYS
SECTION B: THE SURVEY

19. In watter tipe hoërskool was u in Graad 12?
In which type of high school were you in Grade 12?

Stedelike openbare/staatshoërskool / *Urban public/government high school*	1
Landelike openbare/staatshoërskool / *Rural public/government high school*	2
Private skool / *Private school*	3
Stedelike tegniese skool / *Urban technical school*	4
Landelike tegniese skool / *Rural technical school*	5
"Township" – skool / *Township school*	6
Tuisonderrig / *Home schooling*	7
Ander / *Other*	8

20. In watter jaar het u gematrikuleer?
In which year did you matriculate?

21. Wat was u gemiddelde Graad 12-uitslagsimbool?
What was your average Grade 12 result symbol?

A	1
B	2
C	3
D	4
E	5
F of laer / *F or below*	6

22. Tot op hede, in watter van die volgende Wiskundeklasse het u 'n C-simbool of meer behaal? (Kies almal wat van toepassing is.)
To date, in which of the following mathematics classes have you obtained a C symbol or above? (Choose all that are applicable)

	Ja/*Yes*	Nee/*No*	Nie van toepassing *Not applicable*
Wiskunde in Graad 12 / *Mathematics in Grade 12*	1	2	3
Alpha/App-Wiskunde / *Alpha/App-mathematics*	1	2	3
Enige ander Wiskunde op skool / *Any other Mathematics at school*	1	2	3
Analise I / *Calculus I*	1	2	3

4

Beantwoord elkeen van die volgende vrae ten opsigte van Wiskunde op hoërskool EN WISN111.   ***Answer each of the following questions for Mathematics at high school AND WISN111.***

SLEUTEL VIR VRAAG 23 – 26 / *KEY FOR QUESTION 23 – 26*

1→Geen / *None*
2→1 – 2
3→3 – 5
4→6 – 10
5→11 – 15
6→Meer as 15 / *More than 15*

23.

WISKUNDE GRAAD 11 en 12 **WISN111**
MATHEMATICS GRADE 11 and 12

1	2	3	4	5	6		1	2	3	4	5	6
						Ongeveer hoeveel projekte, verslae of enige ander geskrewe take van **1 tot 5 bladsye** het u voltooi? *About how many papers, reports or other written tasks of **1 to 5 pages** did you complete*?						

24.

WISKUNDE GRAAD 11 en 12 **WISN111**
MATHEMATICS GRADE 11 and 12

1	2	3	4	5	6	Ongeveer hoeveel projekte, verslae of enige ander geskrewe take van **meer as 5 bladsye** het u voltooi? *About how many papers, reports or other written tasks of **more than 5 pages** did you complete*?	1	2	3	4	5	6

25.

WISKUNDE GRAAD 11 en 12 **WISN111**
MATHEMATICS GRADE 11 and 12

	Ongeveer hoeveel ure het u bestee aan voorbereiding vir die Wiskundeklas (studie, leeswerk, huiswerk, ens.) in 'n tipiese 7-dagweek? *About how many hours did you spend preparing for the Mathematics class (studying, reading, doing homework, etc.) in a typical 7-day week?*	

26.

WISKUNDE GRAAD 11 en 12 **WISN111**
MATHEMATICS GRADE 11 and 12

	Ongeveer hoeveel ure het u bestee aan buite-kurrikulêre aktiwiteite (organisasies, skoolpublikasies, verteenwoordigende leerlingraad, sport, ens.) in 'n tipiese 7-dagweek? *About how many hours did you spend on extra-curricular activities (organisations, school publications, representative student council, sports, etc.) in a typical 7-day week?*	

Gedurende u **laaste jaar van hoërskool EN eerste semester op universiteit**, ongeveer hoe gereeld het u die volgende gedoen?
*During your **last year of high school AND first semester at university**, approximately how often did you do the following?*

SLEUTEL VIR VRAAG 27 – 37 / *KEY FOR QUESTION 27 – 37*

1→Amper nooit / *Almost never*
2→Soms / *Sometimes*
3→Dikwels / *Often*
4→Baie dikwels / *Very often*

27.

WISKUNDE GRAAD 12 **WISN111**
MATHEMATICS GRADE 12

1	2	3	4	Wiskundeklas bygewoon met onvoltooide huiswerk of opdragte. *Attended Mathematics class with incomplete homework or assignments.*	1	2	3	4

28.

WISKUNDE GRAAD 12 **WISN111**
MATHEMATICS GRADE 12

1	2	3	4	Twee of meer rofwerke van opdragte / tutoriale voorberei voor die finale weergawe daarvan ingehandig is. *Prepared two or more drafts of assignments/ tutorials before the final version thereof was submitted.*	1	2	3	4

29.

WISKUNDE GRAAD 12 **WISN111**
MATHEMATICS GRADE 12

1	2	3	4	Tot gevolgtrekkings gekom gebaseer op u eie ontleding van numeriese inligting (getalle, grafieke, statistiek, ens.) in 'n praktiese probleem. *Reached conclusions based on your own analysis of numerical information (numbers, graphs, statistics, etc.) in a practical problem.*	1	2	3	4

30.

WISKUNDE GRAAD 12 **WISN111**

MATHEMATICS GRADE 12

1	2	3	4	Numeriese inligting gebruik om 'n lewens-werklike/alledaagse probleem te ondersoek (werkloosheid, klimaatsverandering, openbare gesondheid, ens.). *Used numerical information to examine a real-world problem (unemployment, climate change, public health, etc.)*	1	2	3	4

31.

WISKUNDE GRAAD 12 **WISN111**

MATHEMATICS GRADE 12

1	2	3	4	Ander se afleidings van numeriese inligting geëvalueer. / *Evaluated what others have concluded from numerical information.*	1	2	3	4

32.

WISKUNDE GRAAD 12 **WISN111**

MATHEMATICS GRADE 12

1	2	3	4	Sleutelinligting uit opdragte geïdentifiseer. *Identified key information from assignments.*	1	2	3	4

33.

WISKUNDE GRAAD 12 **WISN111**

MATHEMATICS GRADE 12

1	2	3	4	U notas ná die Wiskundeklas hersien. *Revised your notes after the Mathematics class.*	1	2	3	4

34.

WISKUNDE GRAAD 12 **WISN111**

MATHEMATICS GRADE 12

1	2	3	4	Opsommings gemaak van studiemateriaal (handboek/studiegids) of van dit wat u in die Wiskundeklas geleer het. *Summarised course material (textbook / study guide) or what you have learned in the Mathematics class.*	1	2	3	4

35.

LAASTE 2 JAAR VAN HOëRSKOOL **UNIVERSITEIT**

LAST 2 YEARS OF HIGH SCHOOL ***UNIVERSITY***

1	2	3	4	U eie lewensbeskoulike sienings oor 'n onderwerp geëvalueer. *Evaluated your own philosophical views on a topic.*	1	2	3	4

7

36.

LAASTE 2 JAAR VAN HOëRSKOOL *LAST 2 YEARS of HIGH SCHOOL*					UNIVERSITEIT *UNIVERSITY*			
1	2	3	4	Iemand anders se lewensbeskoulike sienings beter probeer verstaan deur u in te dink hoe 'n probleem vanuit sy of haar perspektief lyk. *Tried to understand someone else's philosophical views better by imagining how a problem is perceived from his or her perspective.*	1	2	3	4

37.

GRAAD 12 *GRADE 12*		TANS *PRESENTLY*
	Ongeveer hoeveel ure het u ontspan en/of gesosialiseer (tyd saam met vriende, rekenaarspeletjies, TV-speletjies, aanlyn met vriende gesels, ens.) in 'n tipiese 7-dagweek? *About how many hours in a typical 7-day week did you relax and/or socialise (time with friends, computer games, TV-games, conversing with friends online, etc.)?*	

Gedurende u **hoërskooljare EN universiteitsjare tot dusver**, hoe betrokke was u by die volgende aktiwiteite?
*During you **high school years AND university, thus far**, how involved were you in the following activities?*

SLEUTEL VIR VRAAG 38 – 45 / *KEY FOR QUESTION 38 – 45*

1→Amper nooit / Almost *never*
2→Soms / *Sometimes*
3→Dikwels / *Often*
4→Baie dikwels / *Very often*

38.

HOëRSKOOL *HIGH SCHOOL*					UNIVERSITEIT *UNIVERSITY*			
1	2	3	4	Kultuuraktiwiteite (orkes, koor, teater, kuns, debat, redenaars, Voortrekkers, Landsdiens) *Culture activities (orchestra, chorus, theatre, art, debate, orators, Voortrekkers, boy scouts / girl scouts)*	1	2	3	4

39.

HOëRSKOOL *HIGH SCHOOL*					UNIVERSITEIT *UNIVERSITY*			
1	2	3	4	Sportspanne / *Sport teams*	1	2	3	4

40.

HOëRSKOOL **UNIVERSITEIT**
HIGH SCHOOL ***UNIVERSITY***

1	2	3	4	Verteenwoordigende Leerlingraad *Representative Learner Council*	1	2	3	4

41.

HOëRSKOOL **UNIVERSITEIT**
HIGH SCHOOL ***UNIVERSITY***

1	2	3	4	Publikasies (skoolkoerant, jaarboek, ens.) *Publications (student newspaper, yearbook, etc.)*	1	2	3	4

42.

HOëRSKOOL **UNIVERSITEIT**
HIGH SCHOOL ***UNIVERSITY***

1	2	3	4	Akademiese klubs of vakverenigings *Academic clubs or subject societies*	1	2	3	4

43.

HOëRSKOOL **UNIVERSITEIT**
HIGH SCHOOL ***UNIVERSITY***

1	2	3	4	Godsdienstige jeuggroepe *Religious youth groups*	1	2	3	4

44.

HOëRSKOOL **UNIVERSITEIT**
HIGH SCHOOL ***UNIVERSITY***

1	2	3	4	Skaak / *Chess*	1	2	3	4

45.

HOëRSKOOL **UNIVERSITEIT**
HIGH SCHOOL ***UNIVERSITY***

1	2	3	4	Gemeenskapsdiens of vrywillige werk *Community service or volunteer work*	1	2	3	4

SLEUTEL VIR VRAAG 46 / *KEY FOR QUESTION 46*

1→Amper nooit / *Almost never.*
2→Soms / *Sometimes*
3→Dikwels / *Often*
4→Baie dikwels / *Very often*

46.

LAASTE HOëRSKOOLJAAR *LAST HIGH SCHOOL YEAR*					EERSTE SEMESTER *FIRST SEMESTER*			
1	2	3	4	In watter mate het Wiskunde u uitgedaag om u beste werk te doen, spesifiek in Wiskunde? *To what extent did Mathematics challenge you to do your best work, specifically in Mathematics?*	1	2	3	4

47. Hoeveel ure per week het u addisionele werk vir 'n inkomste gedoen in die eerste semester?
How many hours per week did you spend on doing additional work for an income in the first semester?

48. Hoeveel ure per dag het u vir WISN111 studeer in 'n tipiese 7-dagweek?
How many hours per day did you study for WISN111 in a typical 7-day week?

49. Hoeveel ure per week het u die wiskundesentrum vir addisionele hulp met WISN111 besoek?
How many hours per week did you visit the mathematics centre for additional help with WISN111?

50. Hoeveel ure per dag het u in die eerste semester vir al u modules studeer in 'n tipiese 7-dagweek?
How many hours per day did you study for all your modules in the first semester in a typical 7-day week?

Gedurende die **eerste semester**, hoe gereeld het u elkeen van die volgende gedoen?
*During the **first semester**, how often did you do each of the following?*

SLEUTEL VIR VRAAG 51 – 57 / *KEY FOR QUESTION 51 – 57*

1→Amper nooit / *Almost never*
2→Soms / *Sometimes*
3→Dikwels / *Often*
4→Baie dikwels / *Very often*

	1	2	3	4
51. 'n Ander student om hulp gevra om die WISN111-studiemateriaal te verstaan. *Asked another student to help you understand the WISN111 course material.*				

10

52. Die WISN111-studiemateriaal aan een of meer studente verduidelik. *Explained the WISN111 course material to one or more students.*	1	2	3	4
53. Saam met ander studente vir eksamens voorberei deur bespreking of deurwerk van WISN111-studiemateriaal. *Prepared for exams by discussing or working through WISN111 course material with other students.*	1	2	3	4
54. Saam met ander studente aan WISN111-projekte, opdragte of tutoriale gewerk. *Worked with other students on WISN111 projects, assignments or tutorials.*	1	2	3	4
55. Oor loopbaanplanne met 'n dosent gepraat. *Talked about career plans with a lecturer.*	1	2	3	4
56. U akademiese vordering met 'n dosent bespreek. *Discussed your academic progress with a lecturer.*	1	2	3	4
57. 'n Dosent genader om hulp met WISN111 buite die klaskamer. *Approached a lecturer to assist you with WISN111 outside the classroom.*	1	2	3	4

Gedurende die **eerste semester**, hoe gereeld het u besprekings/gesprekke met persone van die volgende groepe gehad?
*During the **first semester**, how often did you have discussions with people from the following groups?*

SLEUTEL VIR VRAAG 58 – 63 / *KEY FOR QUESTION 58 – 63*

1→Amper nooit / *Almost never*
2→Soms / *Sometimes*
3→Gereeld / *Often*
4→Baie gereeld / *Very often*

58. Persone van 'n bevolkings- of etniese groep anders as u eie. *People of a different race or ethnicity than your own.*	1	2	3	4
59. Persone van 'n ander ekonomiese agtergrond as u eie. *People from a different economic background than your own.*	1	2	3	4
60. Persone met ander godsdienstige oortuigings as u eie. *People with other religious beliefs than your own.*	1	2	3	4
61. Persone met ander politieke standpunte as u eie. *People with other political views than your own.*	1	2	3	4
62. Persone met ander seksuele oriëntasies as u eie. *People with other sexual orientations than your own.*	1	2	3	4
63. Persone met gestremdhede. *People with disabilities.*	1	2	3	4

Gedurende die **eerste semester**, hoe gereeld het u die volgende gedoen?
*During the **first semester**, how often did you do the following?*

SLEUTEL VIR VRAAG 64 – 69 / *KEY FOR QUESTION 64 –69*

1→Min / *Not at all*
2→Soms / *Sometimes*
3→Gereeld / *Often*
4→Baie / *Many*

64. Studeer as daar ander interessante dinge was om te doen. *Studied when there were other interesting things to do.*	1	2	3	4
65. Addisionele inligting van WISN111-opdragte of tutoriale gevind wanneer u nie die studiemateriaal verstaan nie. *Found additional information for WISN111 assignments or tutorials when you don't understand the course material.*	1	2	3	4
66. Deelgeneem aan WISN111-besprekings, selfs al was u nie lus daarvoor nie. *Participated in WISN111 discussions, even when you didn't feel like it.*	1	2	3	4
67. Hulp gevra by dosente of tutors wanneer u met WISN111-opdragte of tutoriale sukkel. *Asked lecturers or tutors for help when you struggle with WISN111 assignments or tutorials.*	1	2	3	4
68. Iets in WISN111 wat u begin het, voltooi ten spyte van uitdagings waarvoor u te staan gekom het. *Finished something in WISN111 you have started, in spite of challenges that you encountered.*	1	2	3	4
69. Positief gebly, selfs as u swak presteer het in 'n WISN111-toets, -opdrag of -tutoriaal. *Remained positive, even when you performed poorly in a WISN111 test, assignment or tutorial.*	1	2	3	4

Gedurende die **eerste semester**, hoe moeilik het u die volgende ervaar in WISN111?
*During the **first semester**, how difficult did you experience the following in WISN111?*

SLEUTEL VIR VRAAG 70 – 74/ *KEY FOR QUESTION 70 – 74*

1→Amper glad nie moeilik nie / *Almost not difficult at all*
2→Effens moeilik / *Little bit difficult*
3→Moeilik / *Difficult*
4→Baie moeilik / *Very difficult*

70. Leer WISN111-studiemateriaal. *Learning WISN111 course material.*	1	2	3	4
71. Bestuur u tyd vir WISN111 *Managing your time for WISN111.*	1	2	3	4

72. Betaal universiteitsuitgawes. | 1 | 2 | 3 | 4
Paying university expenses.

73. Kry akademiese hulp met u studies. | 1 | 2 | 3 | 4
Getting academic help with your studies.

74. Interaksie met die WISN111-dosente. | 1 | 2 | 3 | 4
Interacting with the WISN111 lecturers.

In watter mate kan u die volgende in u akademiese werk by hierdie universiteit toepas?
To what extent can you apply the following in your academic work at this university?

SLEUTEL VIR VRAAG 75 – 81 / *KEY FOR QUESTION 75 – 81*

1→Amper glad nie / *Almost not at all*
2→Redelik / *Fairly*
3→Goed / *Good*
4→Baie goed / *Very good*

75. Duidelik en effektief skryf. *Write clearly and effectively.*	1	2	3	4
76. Duidelik en effektief praat. *Speak clearly and effectively.*	1	2	3	4
77. Krities en analities dink. *Think critically and analytically.*	1	2	3	4
78. Numeriese en statistiese inligting analiseer. *Analyse numerical and statistical information.*	1	2	3	4
79. Effektief saam met ander werk. *Work effectively with others.*	1	2	3	4
80. Rekenaars- en inligtingstegnologie gebruik. *Use computing and information technology.*	1	2	3	4
81. Effektief op u eie leer. *Learn effectively on your own.*	1	2	3	4

Hoe belangrik is die volgende vir u?
How important is the following to you?

SLEUTEL VIR VRAAG 82 – 88 / *KEY FOR QUESTION 82 – 88*

1→Nie belangrik nie / *Not important*
2→Effens belangrik / *Somewhat important*
3→Belangrik / *Important*
4→Baie belangrik / *Very important*

HOE BELANGRIK VIR U
HOW IMPORTANT TO YOU

DIE MATE WAARIN DIE NWU DAARAAN VOLDOEN
THE EXTENT TO WHICH THE NWU FULFILLS THIS NEED

1	2	3	4	82. Om 'n uitdagende akademiese ondervinding te ontvang. *To receive a challenging academic experience.*	1	2	3	4
1	2	3	4	83. Om ondersteuning te ontvang sodat studente akademies suksesvol kan wees. *To receive support to help students succeed academically.*	1	2	3	4
1	2	3	4	84. Geleenthede om met ander studente van ander agtergronde (sosiaal, ras/etnies, religieus, ens.) te verkeer. *Opportunities to interact with students from different backgrounds (social, race/ethnic, religious, etc.)*	1	2	3	4
1	2	3	4	85. Hulp om u nie-akademiese verantwoordelikhede te bestuur (werk, familie, ens.) *Support to manage your non-academic responsibilities (work, family, etc.)*	1	2	3	4
1	2	3	4	86. Geleenthede om sosiaal betrokke te wees. *Opportunities to be involved socially.*	1	2	3	4
1	2	3	4	87. Geleenthede om kampusaktiwiteite en -gebeurtenisse by te woon. *Opportunities to attend campus activities and events.*	1	2	3	4
1	2	3	4	88. Die beskikbaarheid van leerondersteuningsdienste (tutordienste, fasilitering, leeslab, ens.). *The availability of learning support services (tutoring services, facilitation, reading lab, etc.).*	1	2	3	4

Watter van die volgende bronne is vir u van hulp om u opleidingskostes te betaal (onderrig, onkostes, boeke, verblyf, ens.)?
Which of the following sources assist you to fund your education expenses (tuition, fees, books, accommodation, etc.)?

SLEUTEL VIR VRAAG 89 – 94 / *KEY FOR QUESTION 89 – 94*

1→Ten volle / *Fully*
2→Gedeeltelik / *Partially*
3→Glad nie / *Not at all*
4→Onseker / *Uncertain*

89.	Finansiële ondersteuning deur ouers of familielede. *Financial support by parents or relatives.*	1	2	3	4
90.	Lenings / *Loans*	1	2	3	4
91.	Toelae of studiebeurse / *Grants or scholarships*	1	2	3	4
92.	Werk of persoonlike spaargeld / *Work or personal savings*	1	2	3	4

93. Verwag u om by hierdie universiteit te gradueer?
Do you expect to graduate from this university?

Ja / *Yes*	1
Nee / *No*	2
Onseker / *Uncertain*	3

94. Hierdie universiteit was u: / *This university was your*:

Eerste keuse / *First choice*	1
Tweede keuse / *Second choice*	2
Derde keuse / *Third choice*	3
Vierde keuse / *Fourth choice*	4
Vyfde keuse of laer / *Fifth choice or lower*	5

Studentenommer:
Student number:

EINDE VAN VRAELYS
END OF QUESTIONNAIRE

15

ADDENDUM 2: COMPARISONS OF INTERVIEWS

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Academic help	Help from lecturer regularly	Difficult to get help from lecturer	Did not pursue help from lecturer	Help from lecturer irregularly	Help from lecturer rarely	Did not pursue help from lecturer
	Visited Maths centre regularly	Did not visit Maths centre	Visited Maths centre	Did not visit Maths centre	Visited Maths centre	Visited Maths centre
		Refresher course helped inmensely				Refresher course help inmensely
	Help from peers	Did not seek help from peers		Help from peers	Help from peers	
	Help from tutors	Help from tutors	Help from tutors	Help from tutors		Help from tutors

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Classes	Full timetable	Full timetable	Full timetable	Full timetable	Full timetable	Full timetable
				Class attendance on regular basis		
				Uncomfor-table with big classes		

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Lived experience	Experience with Maths - interesting and awesome	Exprience with Maths - challenging but enjoyable	Experience with Maths pleasant	Experience was difficult	Quite difficult	In the beginning good, but near the end difficult
	Tried to understand Maths		Tried to understand techniques	Did not understand the Maths	Understan-ding was not possible	Did not understand the Maths

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Marks	Gr 12 mark - very good	Gr 12 mark - excellent	Gr 12 mark - distinction	Gr 12 mark - distinction	Gr 12 mark - distinction	Gr 12 mark - very good
	1st year mark - satisfied	1st year mark - satisfied	1st year mark - not satisfied	1st year mark - disappointed	1 st year mark - failed	1st year mark - not satisfied and failed the module

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Material	Material was difficult - theorems and integrals	Material was not difficult	Material was difficult - integrals	Material was difficult - definitions and theorems	Material was difficult - lack of self-discipline	Material was difficult - limits

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Partici-pation		Asked questions during class				Working out examples during class
					Did not participate with Maths	

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Preparation		Did revision after hours	Did revision	Did revision irregular	Did revision	Did revision- evenings and weekends
	Tried to prepare for class	Prepared for class in the beginning of semester	Did not prepare for class	Did not prepare for class	Did not prepare for class	Tried to prepare for class
	Prepared for tests- extra material, tutorials, old tests		Prepared for tests - old tests, not exercises	Wanted to prepare thoroughly for tests	Prepared for tests - theorems by heart	Prepared for tests - homework, tutorials, examples

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Progress	Discussions with lecturer regularly	Discussions with lecturer after tutorials			Discussions with lecturer when marks became low	

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Self-efficacy	Persevered with problems	Persevered with problems	Persevered with problems	Presevered with problems	Persevered with problems	Persevered with problems
	Did homework given in class	Did homework of tutorial			Did homework irregularly	

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Study					Studied sometimes with peers	Initially studied with peers
					Preferred to study alone	Preferred to study alone

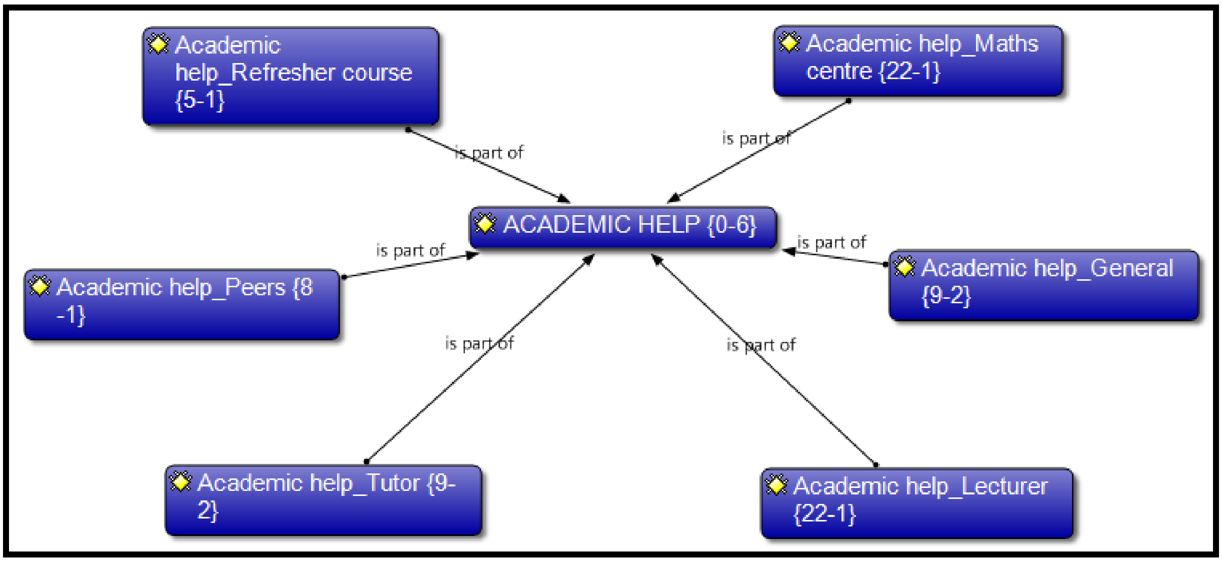
Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Study environ-ment			Transition from school to university was difficult		Transition from school to university was a bit difficult	Transition from school to university was difficult
		Translation to English - positive experience				
		Lived in hostel on campus				
	Home-schooled					

Category	Interviewee 1: Good	Interviewee 4: Good	Interviewee 6: Average	Interviewee 2: Average	Interviewee 5: Poor	Interviewee 3: Poor
Time	Studied 1-2 hours daily	Studied on average 3 hours daily	Studied on average 2 hours daily	Did not study frequently	Studied early daily and sometimes during weekends	Studied on average 2 hour daily
	Time management was difficult because of full timetable	Struggled sometimes with time management	Time management was difficult	Struggled with time management	Time management was problematic	Time management was easy because did not socialise regularly

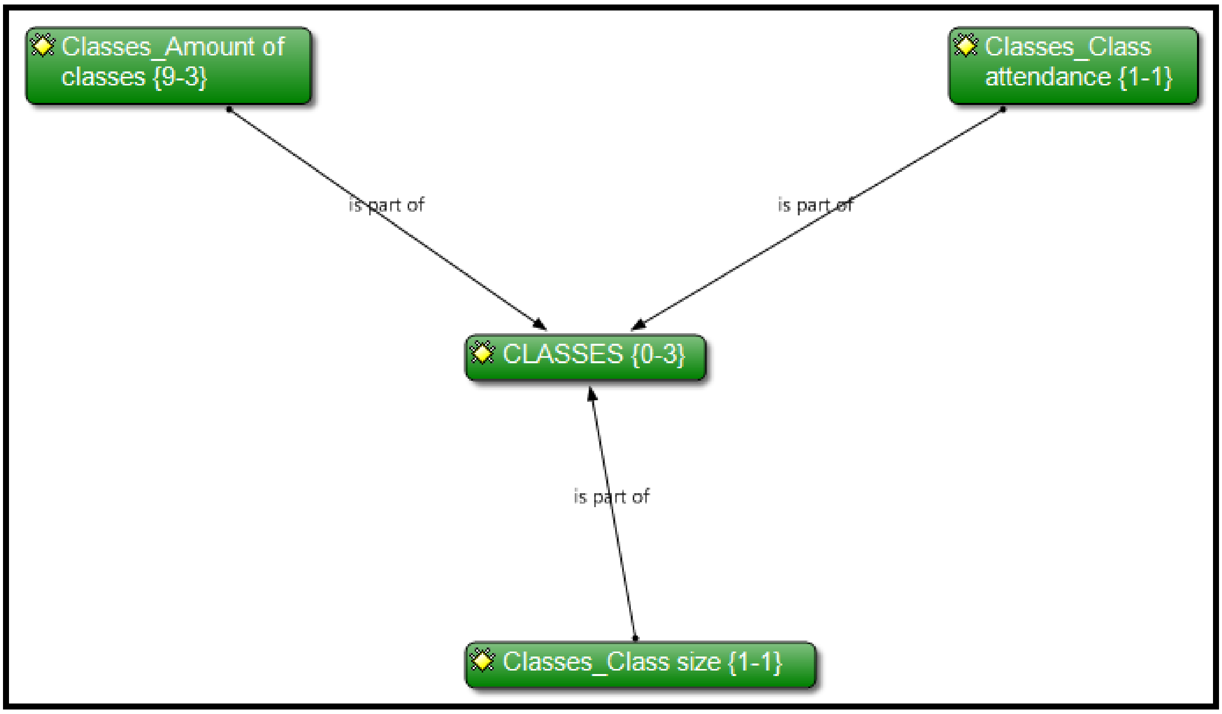
ADDENDUM 3:

NETWORK VIEWS OF CATEGORIES AND CODES

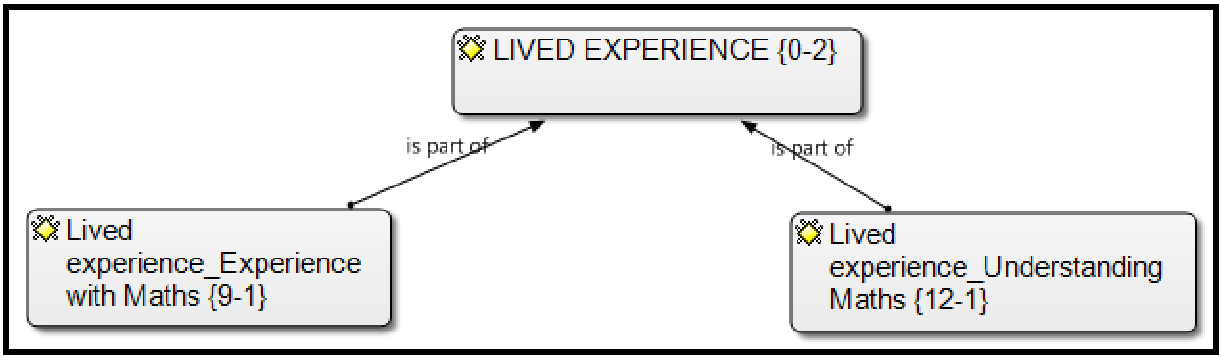
CATEGORY ACADEMIC HELP



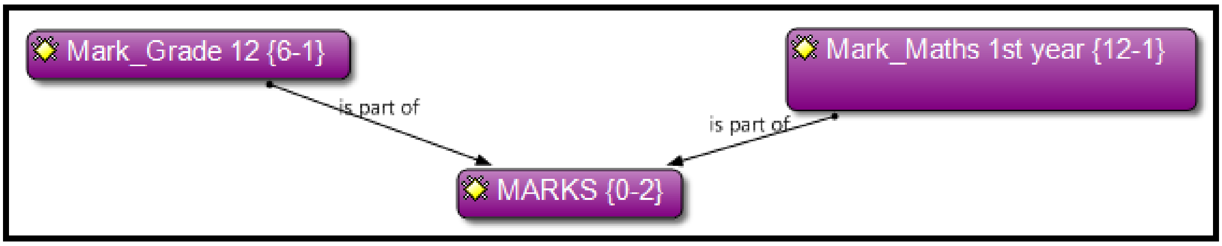
CATEGORY CLASSES



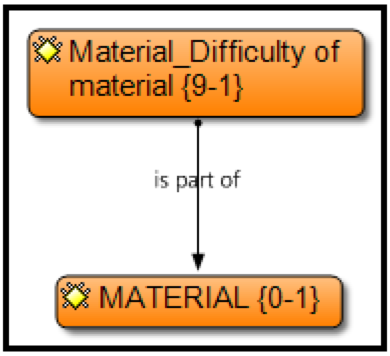
CATEGORY LIVED EXPERIENCE



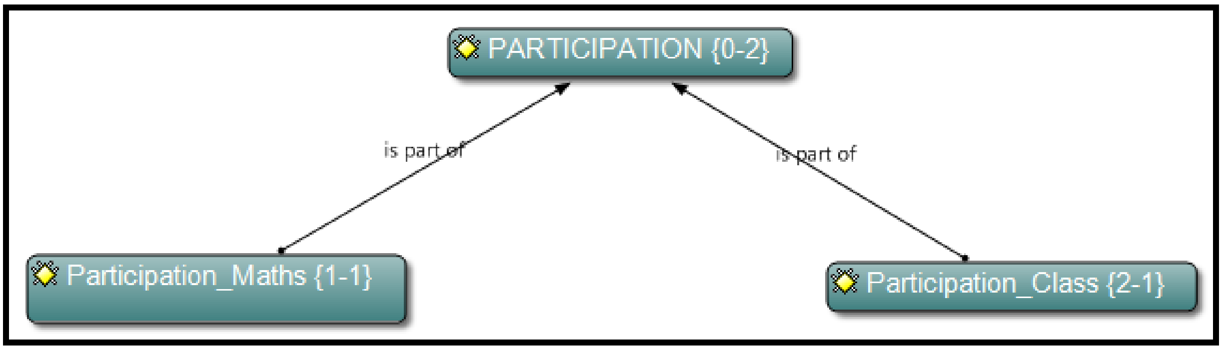
CATEGORY MARKS



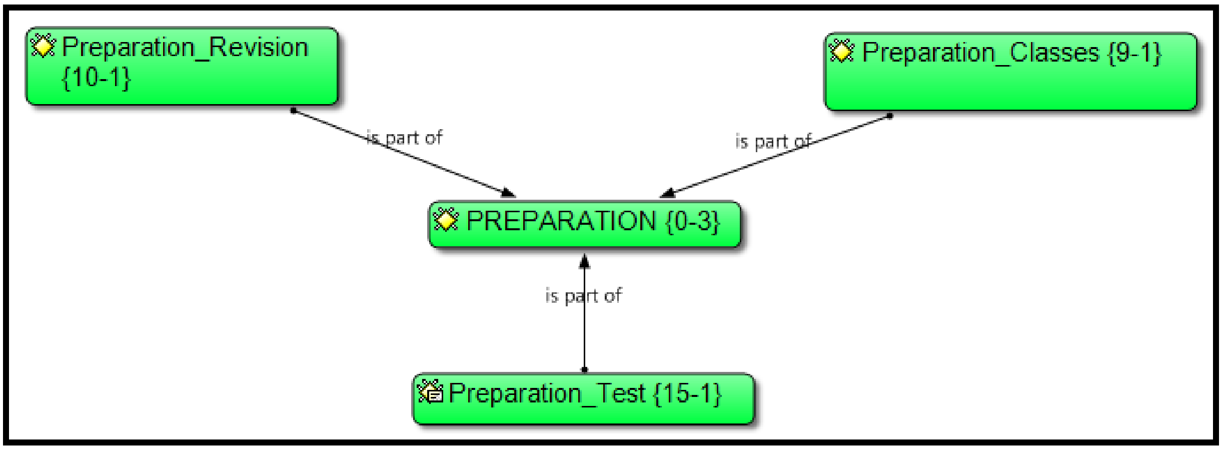
CATEGORY MATERIAL



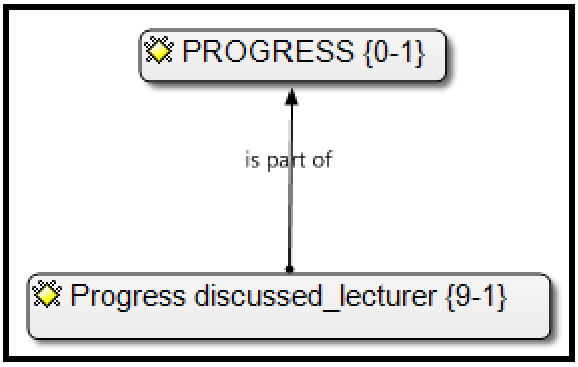
CATEGORY PARTICIPATION



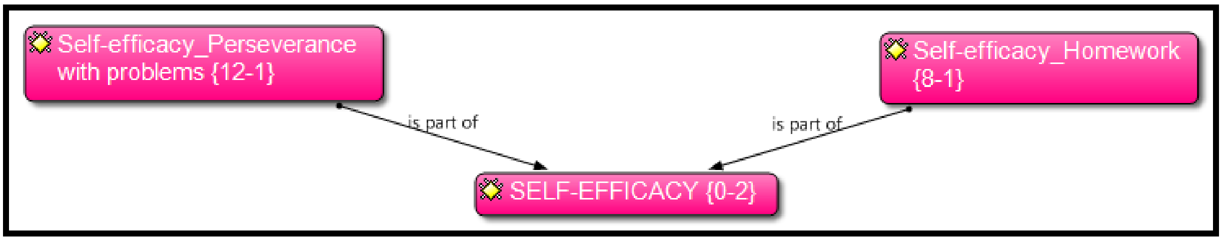
CATEGORY PREPARATION



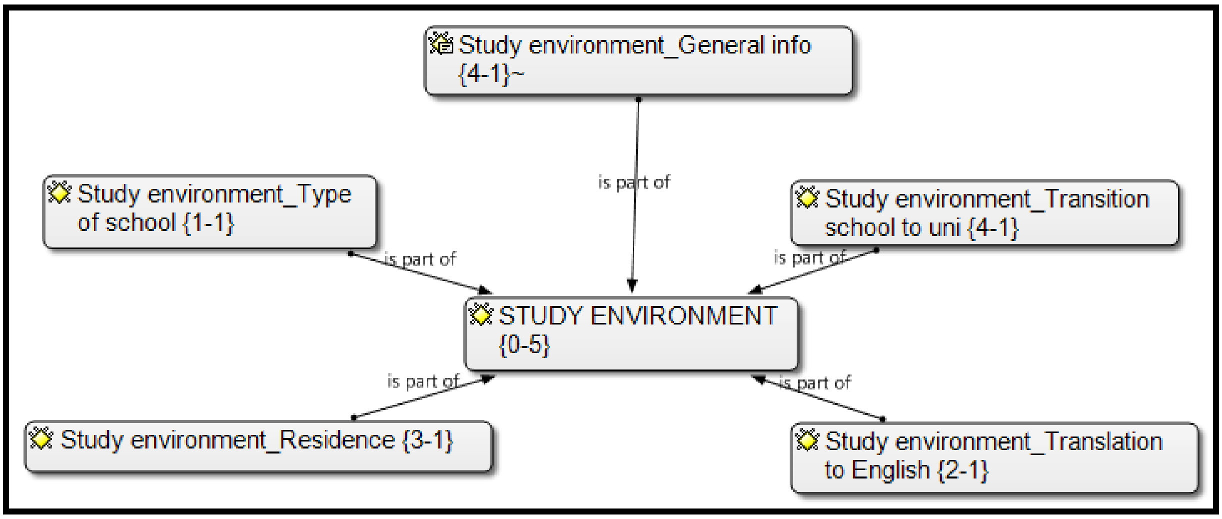
CATEGORY PROGRESS



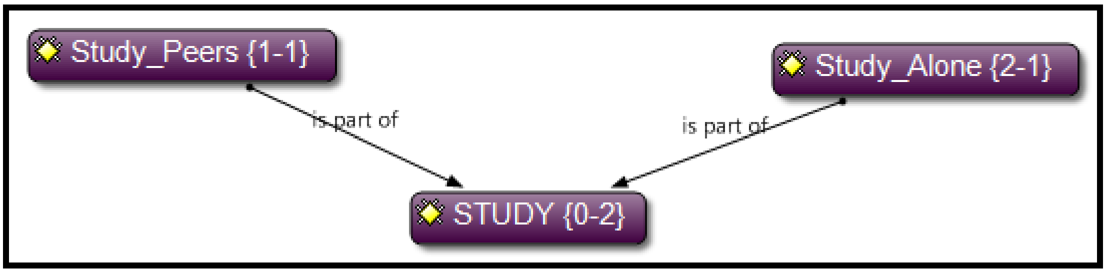
CATEGORY SELF-EFFICACY



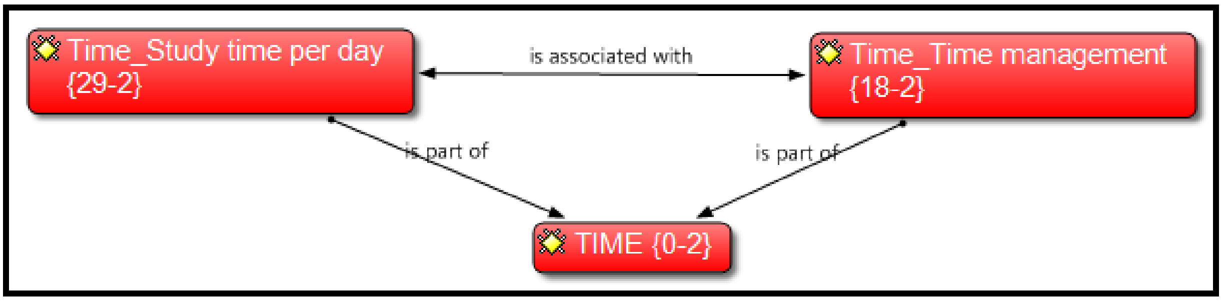
CATEGORY STUDY ENVIRONMENT



CATEGORY STUDY



CATEGORY TIME



ADDENDUM 4: CONSENT FORM

10 JAAR
Dit begin alles hier™

NORTH-WEST UNIVERSITY ®
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOMKAMPUS

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Suid-Afrika, 2520

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Web: http://www.nwu.ac.za

Wiskunde en Toegepaste Wiskunde / Mathematics and Applied Mathematics
Tel: 018 299-4370
Faks:
E-pos: 11153695@nwu.ac.za

Toestemmingsbrief / *Consent form*

Navorsingsprojek oor: "The influence of student engagement on the performance of first-year Mathematics students."
Research project on: The influence of student engagement on the performance of first-year Mathematics students.

Geagte deelnemer / *Dear Participant*

Ek is tans ingeskryf vir my Meestersgraad in Natuurwetenskaponderwys by die Potchefstroomkampus van die Noordwes-Universiteit. My studie handel oor eerstejaarstudente se betrokkenheid met eerstejaars-wiskunde, en spesifiek met WISN111.
I am currently enrolled for my Master degree in Natural Science Education at the Potchefstroom campus of the North-West University. I am conducting a study which is about the student engagement of first-year students with mathematics, and specifically with WISN111.

As jy ingeskryf is vir enige B. Ing-.; B.Sc.- en/of B.Com-graad, en bereid is om deel te neem, versoek ek u vriendelik om hierdie vraelys te voltooi. Die vraelys sal ongeveer 1 uur van u tyd in beslag neem. Deelname is vrywillig en nie verpligtend nie. Jou studentenommer word wel gevra, maar slegs omdat jou punte vir WISN111 benodig word vir die studie. Alhoewel alle inligting vertroulik hanteer sal word, kan navorsingsborge en/of regulerende owerhede die navorsingsrekords inspekteer. Jy sal egter op geen stadium geïdentifiseer word nie. Jy mag kies om op enige stadium van die studie te onttrek. Daar sal geen straf wees vir geen deelname of onttrekking van die studie. Daar is geen risiko verbonde aan jou deelname nie. Resultate gaan gebruik word vir die voltooiing van my M.Sc-graad en kan ook gebruik word vir publikasies en/of by konferensies, sonder om jou op enige manier te identifiseer. Jy kan die navorser en studieleiers kontak om 'n kopie van die resultate te bekom, indien jy belangstel. Data sal op die perseel in geslote store gebêre word vir 'n periode van vyf jaar, volgens die universiteit se regulasies.
If you are enrolled for a B.Ing-, B.Sc- and/or B.Com-degree and are willing to participate, I kindly request you to complete this questionnaire. The questionnaire will take about 1 hour of your time. Participation is voluntary and obligation free. Your student number will be asked, only because your marks of WISN111 are

1

needed for the study. Although information will be kept confidential, research sponsors and/or regulatory authorities may inspect research records. You will however not be identified in any way. You may choose to withdraw from the study at any time. There will be no penalty for non-participation or withdrawal from the study. There is no risk involved with your participation. Results will be used to complete my M.Sc-degree and may be submitted for publication and/or conference presentation, without identifying you in any way. You may contact the researcher and study leaders to obtain a copy of the results should you be interested. Data will be kept on the premises in locked storage according to university regulations for a period of five years.

Sou jy enige navrae hê oor die navorsingsprojek, kan jy die navorser kontak en enige klagtes rakende jou deelname aan hierdie navorsingsprojek kan aan die Navorsingsetiekkomitee gerig word.
Should you have any queries about the research project you may contact the researcher, and any complaints related to your participation in this research project may be directed to the Research Ethics Committee.

Ek bedank u vir u deelname, tyd en waardevolle bydrae tot hierdie projek.
I thank you for your participation, time, and valuable contribution to this project.

Die uwe,
Yours faithfully,
Mev E Weyer

Kontakinligting van die navorser en studieleiers

Contact information of the researcher and study leaders

		Kwalifikasie *Qualification*	*Kontaknommer* *Contact Number*
Navorser *Researcher*	Mev E Weyer	B.Sc Honns	018 299 4370
Studieleiers *Study Leaders*	Dr M Hitge	PhD (Fisika/Physics)	018 299 2579
	Dr A Roux	PhD (Wiskundeonderwys / Mathematics Education)	018 299 1895

Ek ___________________________________ verklaar hiermee dat ek,

- *die inhoud van die navorsingsprojek verstaan,*
- *vrywillig deelneem aan die projek*
- *toestemming gee dat inligting verkry gebruik mag word vir navorsingsdoeleindes maar dat my privaatheid en die vertroulikheid van die inhoud gerespekteer sal word.*

_______________________ ___________________

Handtekening *Datum*

I, ___________________________________ hereby declare that I

- *understand the content of this research project,*
- *participate voluntarily in the project,*
- *grant permission that information obtained may be used for research purposes, but that my privacy and the confidentially of the contents will be respected.*

_______________________ ___________________

Signature *Date*

ADDENDUM 5: ETHICS APPROVAL

NORTH-WEST UNIVERSITY
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Faks: (018) 299-4910
Web: http://www.nwu.ac.za

Ethics Committee
Tel +27 18 299 4849
Email Ethics@nwu.ac.za

ETHICS APPROVAL OF PROJECT

The North-West University Research Ethics Regulatory Committee (NWU-RERC) hereby approves your project as indicated below. This implies that the NWU-RERC grants its permission that provided the special conditions specified below are met and pending any other authorisation that may be necessary, the project may be initiated, using the ethics number below.

Project title: The influence of student engagement on the performance of first-year Mathematics students

Project Leader: **EE Weyer**

Ethics number:

N	W	U	-	0	0	1	9	2	-	1	4	-	A	3
Institution				Project Number						Year			Status	

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Approval date: 2014-11-21 **Expiry date**: 2019-11-20

Special conditions of the approval (if any): None

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- *The project leader (principle investigator) must report in the prescribed format to the NWU-RERC:*
  - *annually (or as otherwise requested) on the progress of the project,*
  - *without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.*
- *The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-RERC. Would there be deviated from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.*
- *The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-RERC and new approval received before or on the expiry date.*
- *In the interest of ethical responsibility the NWU-RERC retains the right to:*
  - *request access to any information or data at any time during the course or after completion of the project;*
  - *withdraw or postpone approval if:*
    - *any unethical principles or practices of the project are revealed or suspected,*
    - *it becomes apparent that any relevant information was withheld from the NWU-RERC or that information has been false or misrepresented,*
    - *the required annual report and reporting of adverse events was not done timely and accurately,*
    - *new institutional rules, national legislation or international conventions deem it necessary.*

The Ethics Committee would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the Ethics Committee for any further enquiries or requests for assistance.

Yours sincerely

Linda du Plessis

Digitally signed by Linda du Plessis
DN: cn=Linda du Plessis, o=NWU, Vaal Triangle Campus, ou=Vice-Rector: Academic, email=linda.duplessis@nwu.ac.za, c=US
Date: 2015.01.23 19:30:05 +02'00'

Prof Linda du Plessis
Chair NWU Research Ethics Regulatory Committee (RERC)

ADDENDUM 6:

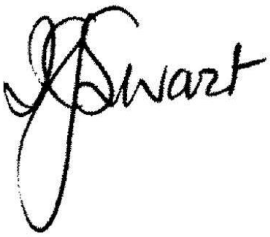
LETTER CONFIRMING LANGUAGE EDITING OF DISSERTATION

This serves to confirm that I, Isabella Johanna Swart, registered with and accredited as professional translator by the South African Translators' Institute, registration number 1001128, language edited the following dissertation, excluding the Table of contents, List of Tables, List of Figures and Bibliography.

The influence of student engagement on the performance of first-year Mathematics students

by

E Weyer



Dr Isabel J Swart Date: 17 November 2016

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