



**POST-GRADUATE STUDENTS' CONCEPTIONS AND  
PERCEPTIONS OF MATHEMATICS - A STUDY OF  
SOCIAL SCIENCE STUDENTS AT THE  
PIETERMARITZBURG CAMPUS, UNIVERSITY OF  
KWAZULU-NATAL**

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**A Masters by Research Thesis Submitted in Fulfilment of the Requirements for the  
Degree of Master of Social Sciences in Sociology at the University of KwaZulu-Natal,  
Pietermaritzburg, Republic of South Africa**

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## **Declaration**

This Masters by research thesis is submitted in fulfilment of the requirements of the degree of Master of Social Sciences in Sociology (Graduate Programme) at the University of KwaZulu-Natal, Pietermaritzburg, South Africa.

I, **Vuyo Nomzamo Gama**, declare that:

The research reported in this thesis, except where otherwise indicated, and is my original research.

This thesis has not been submitted for any degree or examination at any other university.

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## **Abstract**

The study asserts that conceptions and perceptions as meanings that students attach to mathematics either align them or misalign them with the competencies, skills and know-how that qualify one as competent or incompetent in mathematics. The way students perform in mathematics on the other hand also prefigures students' conceptions and perceptions towards mathematics. The way students perform in mathematics, particularly the poor mathematics performance under investigation and differentiated mathematics outcomes are expressions of the success or failure of the collision between the human habitus and habitus that is valued in mathematics learning. Conceptions and perceptions therefore reflect the socio-cultural dynamics, social relations and processes that inform these habituses. This is crucial for understanding the underlying causes of poor mathematics performance by students as a starting point in improving how they perform in mathematics.

The objective of the study is to understand how students' conceptions and perceptions of mathematics influence how they perform in mathematics and in courses with mathematics as the underlying method as expressed in mathematics outcomes. Twelve University of KwaZulu-Natal (UKZN) post graduate (Masters and PhD) students in the social sciences were interviewed for the study. The study also seeks to establish how students' conceptions and perceptions prefigure students' choice of research method for their current research (narratives vs figures) much against this choice being made on the basis of the kind of data. These are investigated within Bourdieu's theory of social practice and social constructivism.

It is salient from the study that all of reality filters through the embodiment of the perceiver or conceiver and that individual students realities are mediated by their social class. Poor mathematics performance is thus an expression of the socio-cultural epistemologies and discourses that characterise various societies, of what mathematics is and how it should be learned. It is the social environment that informs the students' perceptions and conceptions of mathematics and how they come to know and understand themselves as mathematics learners. Active participation in their own learning however challenges some of the socially constructed meanings around mathematics, thus increasing their agential capacity to acquire the valued habitus in mathematics. The study also concludes that findings on conceptions and perceptions are better off not generalised to wider populations as they tend to be the specific groups being investigated.

## Acronyms

<b>Acronym</b>	<b>Meaning</b>
CEPD	Centre for Education Policy Development
CHE	Council of Higher Education
HE	Higher Education
PhD	Doctor of Philosophy
UKZN	University of KwaZulu-Natal
RSA	Republic of South Africa
SADC	Southern African Development Community

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## CHAPTER ONE: INTRODUCTION

### 1.1 Background

The investigation of conceptions and perceptions<sup>1</sup> in learning, particularly in the learning of mathematics has received considerable attention in recent years (Trower, 2005:15). Even in the social sciences, this topic has been of interest within research communities. This includes, but is not limited to the following recent studies: Keiller (2010); Peelo and Francis (2010); Houston (2010); Larkin (2012); Lee (2010) to name but a few. These studies typically focus on the relationship between students' conceptions, perceptions, learning and learning environments. They investigate this relationship in the context of higher education. While some of the studies explore learning in general, others go further to investigate this relationship particularly in mathematics learning at undergraduate level.

The establishment of the relationship between students' conceptions and perceptions and mathematics learning is in keeping with the objectives of the study. Building on the findings of existing studies in the area of students' conceptions and perceptions, this study extends its focus beyond the learning process and learning environments as the space and context within which learning takes place. It focuses on how students perform in courses with mathematics as the underlying method with performance being as an outcome of the success or failure of the mathematics learning process. The study explores the relationship between conceptions and perceptions and learning outcomes from the vantage point of the students themselves and it deviates from focusing on the conventional undergraduate level to focus on post graduate level conceptions and perceptions have partially been explored at higher education (Houston, Marther, Wood and Petocz 2010:70).

The investigation of conceptions and perceptions is a way of exploring people's social realities and the meanings attached to those realities (Leder, Pekoan and Toner 2002:27) and how those realities influence social action. These social realities include but are not limited to social relationships and networks of shared behaviour and they constitute ideal grounds for the process of meaning attribution (Swidler 2007:273). Students' poor mathematics

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<sup>1</sup>(Leder, Pekoan and Toner (2002:27 and 40) define conceptions as "the well thought meanings and interpretations that students attach to social phenomena based on one's personal experience with that social phenomenon". Keiller (2010) further defines perceptions as the awareness of social reality.

performance is one such social reality in the context of the Republic of South Africa's education system. The investigation of students' conceptions and perceptions as a way of exploring people's realities thus unveils the deep seated factors that underlie the social reality of poor mathematics performance. The act of digging deep in search of answers to social problems is in keeping with the objective of the social sciences particularly sociology as it seeks to go beyond the ordinary in understanding the social causation of social problems and in finding solutions to problems in the social environment (Macionis and Plummer, 2007:4).

Conceptions and perceptions as a pool of meanings that people attribute to the world around them, 'mirror' or reflect the ever-changing social landscape. They reflect the nature of social relationships, social interaction, and human behaviour among others. Based on these characteristic features, conceptions and perceptions have been engaged as a useful tool in numerous research circles to gain insight into students' learning behaviour. This study also investigates students' conceptions and perceptions to understand particularly students' poor mathematics performance at post graduate level.

Lerman (1996:140) states that our understanding of the social environment is preceded by our interaction with or experience of the social environment. The various entities that humans interact with in the social environment are detailed in the second chapter. The social environment or social world is the setting in which individual meaning making processes and social relations are embedded. The social environment thus informs meaning-making processes and the nature of social relations. It is partially through the meanings attached to social contexts that people make sense of the social environment. The repeated and continuous interaction with the social environment becomes one's 'encountered world'.

Considering that meanings help us make sense of the social environment as Lerman (1996:140) asserts, so do conceptions and perceptions as meanings. The students' conceptions and perceptions investigated by this study therefore help us understand particularly the causal factors that underlie students' poor mathematics performance and the effects of these factors to the social group being investigated. Since conceptions and perception are specific to the individuals being investigated, the generalisability of the findings of this study is thus beyond the scope of the study.

The gravity of RSA's poor mathematics performance has been described to be a cause for concern. This has been confirmed, among other authors, by Spaul (2013:4) who notes that although RSA is a middle income country, its mathematics overall performance has the lowest average score of all low-income countries that participate in international mathematics assessments. The author further notes that when the sample is limited to mathematics performance in other Sub-Saharan African countries like Swaziland, Tanzania and Kenya, RSA performs worse. This means that students' poor mathematics performance, particularly at higher education, is thus a manifestation of an existing and long standing problem in RSA's education system. The study therefore explores the extent to which the poor mathematics performance problem is echoed in higher education, particularly at post graduate social science level.

Students' poor mathematics performance is a social, economic and personal problem because mathematics is a key area of knowledge and crucial for individual, social and economic development (Anthony and Walshaw, 2009:6). This follows that the modernised society as well as the global community we are living in values and places emphasis on scientific reason which emphasis the utilisation of advanced calculations in explaining social phenomena and logic. Understanding, interpreting and explaining social phenomena and social behaviour is the mandate of the social sciences and it utilises numerous techniques to achieve this, including mathematical applications which are interpreted as 'social talk' in borrowing Restivo's (1993:6) words.

This study's interest in the investigation of students' conceptions and perceptions of mathematics is premised on Crawford, Gordon, Nicholas and Prosser's (1998:467) assertion that "students' perceptions and conceptions interfere with the experience of learning". This assertion confirms the findings of many other studies that maintain that conceptions and perceptions as meanings have a mediatory effect between the experience of learning and how students perform in mathematics or in courses with mathematics as the underlying method in particular. This study explores how the meanings that students attach to mathematics interfere with mathematics learning and how this is played out in how they perform in mathematics and in courses with mathematics as the underlying method.

In line with the objectives of the study, questions that explore the cause and effect of conceptions and perceptions on students' performance in mathematics are investigated. They

are explored in order to shed some light on the continued poor mathematics performance by most South African students and the extent to which post graduate social science students fall into this category of students that are classified as poor in mathematics. The questions include soliciting what the collection or pool of meanings that characterise post graduate social science students as the study population are. It is from the collection of meanings that a pattern of meanings that characterises social science students as a social group is established.

This study also seeks to understand whether the meanings that students attach to mathematics have a bearing on their choice of research method for their current research projects. This is considering that quantitative research has some numerical aspect and that qualitative research is narratives. The question then is, while data is supposed to channel one to the research method to be used for a particular study, to what extent do the meanings that students hold influence their research method in favour of methods of their perceived competence. Moogan, Baron and Harris (1999:220) note how the course program and course content act as key determinants on student's choice and preference for disciplines and courses that students enrol for. This study therefore seeks to establish if, by that same token, students' conceptions and perceptions of mathematics influence the choice of research method students use for their research studies considering that course content, particularly mathematics content is part of course specifics.

The 'interference of conceptions and perceptions to learning' as Crawford et al (1998:467) assert, can be viewed as the characteristic feature of lenses as they either illuminate or obscure vision. Viewing conceptions and perceptions as lenses is Lerman's (1996:140) idea. 'Illumination of vision' is where students' conceptions and perceptions are a platform upon which learning builds and 'obscuring vision' on the other hand is when conceptions and perceptions are a stumbling block or a hindrance to learning. This therefore emphasises the significance of aligning students' meanings, views, interpretations and understanding of mathematics with the mathematical way of knowing. The 'challenge' is mainly where the students' interpretations are not aligned with the mathematical way of knowing as they have to be traded for, given up or aligned with the institutional or mathematical way of knowing, as the mathematics field has specific principles on how and when to solve mathematical operations.

The decision to base the study on the social sciences is that the social sciences follows Durrheim and Tredoux's (2002: v) assertion that the social sciences has a diversity of students with varied mathematical skills, capabilities, cultures and backgrounds. The diversity essentially implies that they are a broadened social plane and fertile ground for the display of varied meanings to mathematics. The study therefore explores if this assertion holds true for this particular social group and if so, what are the implications on their research methods particularly quantitative research.

The study of students' conceptions and perceptions in explaining learning outcomes has predominantly captured the attention of the fields of psychology and education other than sociology. This assertion is substantiated by the volume of psychology and education publications on students' perceptions and conceptions of mathematics. The cognitive psychology perspective is the most prominent in the mathematics conceptions and perceptions subject with sociology slowly gaining recognition (Houston, Marther, Wood and Petocz, 2010:70). While cognitive psychology views conceptions and perceptions as 'cognitive lenses' and how the brain acts on sense data<sup>3</sup> to process meaning, sociology is more in line with social psychology which emphasis the interaction between the individual and social structures in prefiguring human behaviour. Sociology advocates the centrality of the social in prefiguring mind processes. The study's sociological orientation therefore aims to conceptualise conceptions and perceptions not as being only of cognitive nature but as being of cognitive nature subsumed by the social and as an outcrop of culture (Gerhards, 2005:4-8). The education field on the other hand focuses on the totality of activities, personalities, practices and so on, that influence learning and learning outcomes. Essentially, the field of education is concerned with how students relate to various aspects of the learning environment. The fields therefore differ in their ontological (nature of reality), epistemological (nature of knowledge) and methodological assumptions. There are however areas of mutual interest.

Most studies in this area of study resort to using either the perceptions or conceptions concept or use them interchangeably. Among these are studies like Douglas (1996) on 'Student Conceptions of Mathematics'; Entwistle (1991) in 'Approaches to learning and Perceptions of Learning Environment'; and Houston et al (2010) in 'Student Conceptions of

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<sup>3</sup> Sense data is the direct apprehension of things given or presented by the senses –given by the sense of sight, memory, touch etc according to Moore (1993:29).

Mathematics' to name but a few. This study however uses both concepts to acknowledge the differing processes that give rise to these meanings regardless of the fact that "the concepts are not easily distinguishable and that they cannot be reduced to the immediate observable aspects of behaviour" (Ponte, 1994:2). Perceptions arise as a result of awareness of social phenomena (Keiller, 2010:7). Conceptions on the other hand extend beyond awareness to encompass critical interrogation and introspection of experiences and social phenomena<sup>7</sup> by individuals and thus giving rise to subjective, individual and different/variable responses to a concept. As Steffe and Gail (1995:52) argue that conceptions and perceptions exist only in terms of each other as conceptions develop from perceptions and perceptions channel conceptions. The use of both concepts therefore is an effort not to mask the processes that give rise to these concepts<sup>8</sup> and it makes no effort to distinguish them in analysis.

## **1.2 Mathematics in the Social Sciences**

Establishing the place, relevance and application of mathematics in the social sciences is of utmost significance. This follows from some anticipated concerns on why mathematics investigation should be in a place where arguably there is no mathematics. Considering the possibility of such sentiments, this discussion therefore is of utmost significance as a starting point.

This study explores mathematics not as a major method but as "the underlying method in statistics and quantitative research" (Muijis, 2004:3). The application of mathematics in most of the social sciences significantly lies in statistics and quantitative methods as mathematics-based methods. The study investigates mathematics as opposed to statistics or quantitative methods as applied in the social sciences, because the underlying problem that puts a lot of students off doing statistics<sup>9</sup> and quantitative research in the social sciences, is the mathematics underlying these applications as students find it intimidating (Muijis, 2004:3). Mathematics or "congenital mathematics deficiency syndrome" as Babbie (1998:458) calls it, is the common cause of problems even for statistics and/or quantitative methods. Addressing mathematics as the underlying problem therefore is a worthwhile endeavour and makes logical sense as it addresses a problem that affects more than one area in the field of learning.

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<sup>7</sup> Idea from Pawan et al. (2003) as quoted by Keiller (2010:7)

<sup>8</sup> Idea borrowed from Rubenstein (2001:146)

<sup>9</sup> Schacht and Brad J. Stewart (1990:52) states that helping students to overcome mathematics anxiety ought to be an explicit goal even in statistics courses.

Edling (2002:200) summarises the relevance of mathematics in the social sciences as grounded not only in “the description of what happens and of how the different parts of the social system are related, but also the rational processes that can be formulated and analysed mathematically for clarity and precision where our reasoning about phenomena is too complex to be handled in words”. The social sciences therefore do not only limit themselves to qualitative interpretation and the description of data and ideas, but equally privilege mathematical techniques for ‘precision and clarity’ in its presentation of ideas. This emphasises the complementarities between mathematical applications and non-mathematical applications in the social sciences.

The utilisation of mathematics in the social sciences is not a new practice. Elding (2000:198) retraces the use of mathematics in the social sciences to an eighteenth century study on probability and decision-making conducted by de Condorset, a French philosopher. The author argues that what has been witnessed lately through computerised mathematical and statistical packages, is evidence of a growth, expansion and realisation of the de Condorset project in the social science field. It also attests to the social sciences’ obligation to embrace the interdisciplinary nature of modern society. The place of sociology as a branch of the social sciences in the investigation of students’ conceptions and perceptions of mathematics is the comprehension of mathematics not as a technical subject but as a social practice. This therefore makes it possible to establish the web of factors and processes that explain social causation within the mathematics symbolic language (Restivo, 1993:7). The significance of the application of mathematics in the social sciences has also been echoed in the Centre for Education Policy Development (CEPD) Conference report (2012:9) as it emphasises that it is important for social science students to demonstrate a level of competency in mathematics otherwise the field will be affected negatively by its complacency in mathematics.

### **1.3 The Research Context and Setting**

The significance of highlighting the research context and setting is a sociological principle grounded in classical sociology which emphasises that human action is explained within its social context or parameters within which it occurs. Establishing the research context also follows the nature of conceptions and perceptions being “contextually specific” (Entwistle, Wood, Smith and Petocs 2004:412). That is, space (geographical, economic, historical, social

etc), actors, time and activity are important factors in framing conceptions and perceptions. Establishing the research setting and context is also instrumental in illustrating how the study seeks to achieve its objectives. Examples of questions underpinning the research context and setting include but are not limited to: Why is the study focusing on post-graduate social science students? In what context is mathematics looked at? which post-graduate level is the study focusing on? and why mathematics and not statistics or quantitative methods among others?

The study investigates conceptions and perceptions primarily within the context of teaching and learning<sup>10</sup>. It looks at the formal classroom setup and the informal execution of mathematics activities outside the classroom throughout the students' educational trajectory. This follows from the idea that it is an accumulation of the students' mathematical experience that informs their conceptions and perceptions of mathematics. The characterisation of the students' conceptions and perceptions is two pronged. It focuses on mathematics as a subject/course and on mathematics as individual mathematical operations. This is in light of Entwistle's (2004:412) postulation that "conceptions are contextual and situated". For instance some students want nothing to do with anything mathematical and thus it is relevant to look at their conceptions and perceptions of mathematics as a subject or course. There are also those students whose perceptions and conceptions vary with mathematical operations, so it is relevant to look at their perceptions and conceptions in relation to mathematical content. The idea of viewing conception and perceptions of mathematics as situated in mathematics as a noun (the subject) or in mathematics as a verb (the operations) has been advanced by Entwistle (2004: 411) as discussed in the literature.

The study focuses on Masters and PhD post-graduate students of social science. The Pietermaritzburg (PMB) campus at UKZN<sup>11</sup> is the study's setting. The PMB campus is one of five UKZN campuses and it is located in the capital of the province of KwaZulu-Natal offering programmes at undergraduate and post-graduate levels. The School of Social Science is under the College of Humanities and is made up of the Development, International and Public Affairs and Society and Social Change Cluster. The Culture cluster is not represented at post-graduate level on the PMB campus.

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<sup>10</sup> Borrowing from Trower's (2005:15) idea of teaching and learning, reference in this particular case is made to teaching and learning as encompassing teaching, learning, assessment and research.

<sup>11</sup> Information on the University of Kwa-Zulu Natal sources from the university website at [www.ukzn.ac.za](http://www.ukzn.ac.za) and on the School of Social Science website.



In comparison to the pure sciences, social science disciplines have lower mathematics requirements except for courses that have high mathematical content such as education where mathematics is a major, and economics, particularly where it is part of the social science discipline. Generally, mathematics in the social sciences is an underlying method in some courses. This therefore renders the social sciences a preference for some students who mathematics is not their strong area. Could it be that the entry requirements are a filter for students who are avoiding mathematics or are just poor in mathematics? Could it also be that the entry requirements are a misleading signal for the students' expectations of the mathematical content and its value in the social sciences? These are some of the questions that the study interrogates in establishing what frames students' perceptions and conceptions of mathematics.

The University of KwaZulu-Natal (UKZN) School of Social Science is also characterised by a diversity of disciplines, some of which make extensive use of mathematics, while others use very minimal mathematics such as pre-calculus or introductory mathematics and statistics, and others do no mathematics at all. Some examples of courses that use significant elements of mathematics at post-graduate level at UKZN include, but are not limited to, Research Design and Statistics, a research module with course code Socy 703P1, in which Babbie (1998:458) as one of the course's prescribed textbooks, assures students that "the mathematics in the course is a mere convenient and efficient language for accomplishing the logical operations inherent in good data analysis". It is this very mathematics language that Muijis (2004:3) argues is what puts a lot of students off. Students who are enrolled for the Socy703P1 module include, among others, students from Policy, Information Studies, Gender Studies and Sociology at UKZN (PMB campus) at post-graduate level. Courses that use limited elements of mathematics in the UKZN social sciences include Data Analysis and Presentation (LIIS834P1) for Information Studies; courses that have limited elements of quantitative methods includes Foundations of Political Inquiry (Pols716) for Politics students<sup>12</sup>. Such diversity in levels of mathematics proficiency among the social science students renders the discipline fertile ground for the investigation of students' perceptions and conceptions of mathematics. This is because the discipline features students of varying educational backgrounds, mathematics experiences, races, and historical backgrounds.

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<sup>12</sup> Information on mathematics content in Politics sourced from PhD students at UKZN (PMB)

#### **1.4 Rationale of the study**

Houston et al (2010:70) note that, regardless of the fact that mathematics provides foundational skills for a variety of disciplines, the area of students' conceptions and perceptions at higher education level has been only partially explored in providing explanations for the continued students' poor mathematics performance. Most of the existing studies in the investigation of students' perceptions and conceptions at higher education level are of a psychological orientation particularly cognitive psychology. Social psychology and in particular Sociology has not featured prominently in this area. This study therefore is an effort to contribute to the literature in the sociology field in particular and the field of learning in general, a sociological understanding of the place of students' conceptions and perceptions in relation to students' performance in mathematics.

The sociological viewpoint adequately establishes the place of students' conceptions and perceptions as meanings in structuring the social. It also explores how the social informs conceptions and perceptions. The interaction between the conceptions and perceptions and the social in relation to poor mathematics performance as a social problem is of utmost significance. This is because society continues to be shaped and divided based on the possession of the mathematics disposition and its lack thereof.

Considering that the RSA government is prioritising science and mathematics as "key areas of knowledge and competence for individual, social, economic and political development" (Anthony and Walshaw, 2009:6), the study is thus a contribution to this developmental goal. This is because it seeks to understand the social dynamics that underlie students' 'poor mathematics with a goal to improve such a status quo. Furthermore, the study is not only an academic endeavour, but it also has some practical implications particularly in mathematics learning in so far as educational policy making at post graduate level. It gives insight on the dynamics of student learning behaviour and how this is expressed in how students eventually perform in learning.

## **1.5 Statement of the problem**

The standard at Masters and PhD level is such that students at this level should possess and demonstrate a higher level of reasoning and ability to apply knowledge independently and critically (Gibbs, 2010:2). This performance standard continues to be sacrificed and undermined by “students’ inability to undertake quantitative work independently because the concepts in quantitative work are mostly presented in the mathematics language” (Gibbs, 2010:2). The author also argues that the inability to be independent in undertaking quantitative work presented in the mathematical language, points to a lack of mathematics proficiency by students. The study therefore establishes whether Gibbs (2010:2) assertion that “incompetence in mathematics culminates inability to undertake quantitative work independently” holds true for post-graduate social science students as that would imply that the quality of quantitative research produced by students that cannot undertake quantitative work independently is also compromised. This further impacts negatively students’ general competence in mathematics particularly in the job market. As it is, “there is low trust about the quality of social science students in the job market as South Africa is not producing the new corps of thinkers who can nurture socio-economic alternatives” (Humanities and Social Science Charter Report, 2012:5 and 39). Crawford et al (1998:467) argue that “students’ perceptions and conceptions of mathematics interfere with the experience of learning”. The study therefore explores students’ perceptions and conceptions of mathematics as a way of establishing and understanding the lack of mathematics proficiency by social science students.

## **1.6 Significance of the Research**

Firstly, the study seeks to establish whether assertion that social science students are poor in mathematics can be generalised across social science student populations particularly whether it holds true for the Pietermaritzburg post graduate social science students. Such an establishment would inform efforts to address the long-standing problem of students’ poor performance in mathematics that epitomises the RSA education system generally particularly for the target group under investigation. This is with taking cognisance that addressing a

problem begins with understanding and fully comprehending the targeted problem. This is the contribution that the study seeks to make: an understanding and full comprehension of the poor mathematics performance problem as a starting point in addressing the problem.

Secondly, since conceptions and perceptions are a product of the social, the variation in students' perceptions and conceptions investigated by the study provides an understanding of how various social contexts and social conditionings inform these conceptions and perceptions. On the other hand, the study establishes how conceptions and perceptions shape and structure social action, particularly student learning behaviour and eventually learning outcomes. Such awareness of the social body and the social processes that shape and reproduce our social environment are instrumental in providing insight into how to reshape, redirect or re-channel those social processes to the advantage of the social body in the face of social ills.

Thirdly, the sociological nature of the study is also a significant milestone in the study of conceptions and perceptions whose territory is largely monopolised by the field of psychology particularly cognitive psychology. This provides an array of interpretations of the poor mathematics performance problem, thus increasing the probability of addressing the problem or at least comprehending the problem from multiple viewpoints. Its particular focus on conceptions and perceptions as meanings gives impetus to a subject that has been 'glossed over' by most studies. The qualitative nature of the study captures the deep seated issues of meanings and the attribution of meanings. This is not to suggest that the quantitative approach is not concerned with meanings. As Gerhards (2005:7) notes, the differences in the qualitative and quantitative approach lies in the depth that the qualitative approach gives the investigation, thus giving it a critical approach in the analysis of situations.

Finally, the study captures current meanings attached by UKZN's social science students to mathematics. This is because time and space is of the essence in meaning attachment to social contexts, as meanings change with changes in time periods, social environments and contexts. The significance of these meanings attached by students to mathematics currently is that it reflects the present status of social reality.

## **1.7 Research Aim, Objectives and Research Questions**

### **1.7.1 Aim of the study**

The study seeks to establish the range of meanings which post-graduate social science students attach to mathematics and how they influence the way students perform in mathematics as expressed in mathematics outcomes. It also seeks to establish the social, economic or cultural factors that mediate student's meaning making processes and the possible influence this may have on the research methods approach in their studies.

### **1.7.2 Research objectives**

The objectives of this study are:

- To explore the varied meanings (conceptions and perceptions) attached by students to mathematics
- To establish what informs students' perceptions and conceptions of mathematics
- To understand how students' conceptions and perceptions influence mathematics outcomes, research choices and mathematics learning

### **1.7.3 Research Questions**

The research questions that are explored to achieve the research objectives are:

- What are post-graduate social science students' conceptions and perceptions of mathematics?
- Why do post- graduate social science students interpret mathematics the way that they do?
- To what extent do post-graduate social science students' conceptions and perceptions of mathematics influence their choice of research method for their post graduate studies?
- What is post graduate students' perceived usefulness of mathematics in post-graduate social science studies?
- What is the connection between post-graduate social science students' conceptions and perceptions and mathematics outcomes?

## 1.8 Key concepts

This refers to the well established concepts that apply to this study and how they are used in the study.

**a) Mathematics:** Mathematics is an activity that expresses solutions to social problems by using a communicative and instrumental system of symbols as a means of articulating the solutions (Godino and Batanero, 1998:3; RSA Department of Basic Education, 2011:8).

**b) Quantitative Research and Qualitative Research:** They are research methods that are used in social research. Quantitative research is a research method that “explains phenomena by collecting numerical data that are analysed using mathematics as underlying the methods” (Muijis, 2004:1) and Qualitative Research refers to the non-numerical approach to or research method for the description and understanding of social action (Babbie, 1998:646).

**c) Learning:** Refers to people’s acquisition of knowledge and in this case mathematical knowledge in formal (classroom) or non-formal contexts (as part of daily life outside the classroom) (Lerman, 1996:146).

**d) Teaching and learning approach:** The teaching and learning approach refers to what the teacher does in teaching and what the student does in learning. That is, it is an interrelationship between the learning approach and the teaching methods.

**e) Mathematics proficiency:** It is the ability to apply knowledge gained during learning. This is particularly a requirement in later years of the education trajectory where their learning is beyond learning basics but mastery of content. Mathematics proficiency therefore can be loosely defined as students’ ability to apply the mathematical knowledge that they have acquired, independently and autonomously in different life contexts. The opposite is true for the lack of mathematics proficiency which implies that the student lacks the mathematical knowledge base and is thus significantly handicapped in mathematical application. This is expressed in mathematics outcomes or marks as a yardstick for mathematics capabilities (Lee and Paik, 2010:17).

**f) Mathematics outcomes and learning outcomes:** Mathematics outcomes are the intended (positive outcomes) or unintended products or goals in mathematics learning<sup>13</sup> as expressed in results or marks. The study views the acquisition of mathematical knowledge as outputs or products in the mathematics learning process. The ability to apply the gained knowledge independently and conversantly to real life situations and particularly in other educational situations, such as in research and courses with mathematical applications, is therefore the outcome. Likewise, learning outcomes are the intended and unintended goals in learning generally. Essentially, success or failure is the two learning outcomes.

### **1.9 Structure of the Dissertation**

The first chapter as an introductory section is a summary of the study's main themes and a highlighting of the scope of the study's interest and the knowledge gap that it seeks to fill. It is a sociological orientation to the study of students' conceptions and perceptions of mathematics. This chapter further examines the place of mathematics in the social sciences and highlights the study context, relevance and significance. It finally clarifies the concepts that are mostly used in the study and highlights a list of the research questions to be explored.

Chapter Two is two pronged. It presents the conceptual and the theoretical framework. The conceptual framework gives attention to the sociological angle by which the study should be comprehended. This is to bring an understanding of how the interpretation of conceptions and perceptions as meanings should be conceived as well as their place in the study. Linked to the sociological angle is the theoretical framework. It presents the theoretical frameworks upon which the study is investigated. It begins with a discussion of social constructivism as the philosophical position that emphasises the varied interpretation of social reality by individuals which is however reconciled through meaning negotiation in mathematics learning. It also adopts Pierre Bourdieu's theory of social practice in explaining how social conditionings predispose students into certain ways of perception and conception and not others; and how this is played out in what students are competent in, comfortable with and not, their preferences and so on.

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<sup>13</sup> Idea borrowed from Matthewman, West-Newman and Curtis (2007:308)

Chapter Three discusses the different ways that students have been found to perceive and conceive mathematics. The chapter further explores how the learning environment including some practices in the learning environments and social relations influence how students come to view themselves as mathematics learners and how this is expressed in their performance. Socio-cultural factors like race, gender and social class that cut across classroom practice are also explored. Attention is also given to the RSA education system and how historical experiences prefigure the structural orientation of the current education system and consequently students' performance.

Chapter Four is the methodological section. It outlines the various processes and stages that the research methods and design that is used to conduct the study and describes the actual procedures as informed by the phenomenographic approach.

Chapter Five reports the results of the study and presents the findings from the data collected. This section presents the results of the phenomenographic outcome space<sup>14</sup> and its discussion. Attention is given to both submission of the majority of the students and those of the minority to balance the arguments. Where some submissions are omitted, it means those views have already been articulated in some of the submissions that are included. This section of the study also follows up on the social and cultural factors that inform the meanings that students attach to mathematics and how those meanings also influence their educational choices particularly pertaining to research. The chapter ends with a discussion of the conclusions drawn from the study and these are presented in the sixth chapter.

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<sup>14</sup> Reid, Wood, Smith and Petocs (2005:570) define an outcome space as “a hierarchical set of logically related categories from the narrowest and most limited to the broadest and most inclusive”.



## **CHAPTER TWO: CONCEPTUAL AND THEORETICAL FRAMEWORK**

### **2.1 Conceptual Framework- Introduction**

This chapter is presented as two sections. The first section is the conceptual framework and the second section is the theoretical framework. The conceptual framework starts off by presenting the definitions of conceptions and perceptions from the cognitive psychology and the sociology perspectives as dominating fields in the field and how they are applied particularly in the education field. This is so as to set the tone for the study's conceptualisation of conceptions and perceptions of mathematics from a sociological viewpoint in the process. Vithal, Adler and Keitel (2005:7) note that "the dominance of the psychological perspective in issues of mathematics learning is slowly falling and increasing emphasis is now on the social/sociological perspective".

The conceptual framework section pays attention to the life, characteristic features and nature of conceptions and perceptions as meanings. This is instrumental in shedding some light on how they are used in the study as well as how they interrelate with other social processes in providing insight into the students' mathematics performance being investigated. They are explained within the Giddens' agency/structure framework.

The second section focuses on the theoretical framework and is an extension of the conceptual framework. Two theoretical frameworks are utilised in the interpretation of the nature and life of meanings, and their place in the lack of mathematics proficiency being investigated. These theoretical frameworks look for probable interpretation and understanding of how social contexts, particularly the nexus of social interactions that one is engaged in, as mediated by class, predispose individuals to certain ways of viewing the world (Crawford et al., 1998:456). This essentially relates to how the meanings that people attach to the social world around them shape and prefigure their behaviour or how they act towards the social world. This translates to how students' perceptions and conceptions of mathematics as informed by the social environment predispose students to act towards mathematics and eventually how the students perform in mathematics.

### **2.2 Conceptions and Perceptions**

Conceptions and perceptions (as noted in the first chapter), mirror people's realities about the social environment. It is in the interest of the study therefore, considering its sociological

nature, to understand and interpret social reality and its evolutionary nature. The meanings that students attach to mathematics are thus instrumental in establishing the students' social and practical realities with mathematics. Steffe and Gale (1995:98) note that the significance of engaging conceptions and perceptions in research is to acquire knowledge on how students engage with the various aspects of their learning environment and how these influence their learning outcomes. Such is the social reality that the study investigates.

This section of the study begins with a discussion of the definitions of conceptions and perceptions. Particular attention is given to how the dominant fields in the study of perceptions and conceptions have interpreted the concepts. There is also an interpretation and understanding of these concepts as meanings and the various kinds of meanings, as well as the key characteristic features of conceptions and perceptions as meanings. This is to establish a clear and standard line of reasoning and understanding as the concepts are applied in subsequent discussions of this study.

Cognitive psychology refers to conceptions and perceptions as the mental representations that individuals have. Where conceptions are defined as well thought mental representations, perceptions on the other hand are the 'vague' representation of social objects in one's mind. In other words, cognitive psychology emphasises mental processes in the comprehension of the social environment.

Sociologically, perceptions and conceptions are collectively referred to as meanings. This is because as social processes through which society is viewed, they mirror the meanings that people attribute to the world around them (Leder, Pekoer and Toner, 2002:27). Meanings are loosely translated as the interpretations that people attach to 'aspects of social reality'<sup>15</sup>. The aspect of social reality in this case is mathematics. Borrowing from Godino and Batanero (1998:3) and Sfard's (2003:13) definition, mathematics is an aspect of social reality because it is a product of humans as social beings engaged in "an act of finding solutions to social problems using a symbolic language as a communication-mediating tool". This study utilises the conceptions and perceptions concepts and the 'meanings' expression interchangeably throughout the study.

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<sup>15</sup> Aspects of social reality can be anything in the social environment such as social objects, symbols, and people - anything and everything that people interact with.

It is through meanings that we understand the world and our place in it (Trowler 2005:19). This means that through meanings we are aware of what we are doing and why we are doing it, and why those around us do what they do. This interconnection of awareness and interpretation drives our understanding of who we are and what we are about. In essence, meanings are an integral characteristic feature through which social interaction is facilitated.

The reason students attach meanings to mathematics is because, like any other social object and social activity that they attach meaning to, mathematics is both a symbolic social object and a social activity. Mathematics as a symbolic social object refers to mathematics as a subject while mathematics as a social activity refers to the act of attaching meaning to the individual operations (parts) of the symbolic mathematical language. For example, some students want nothing to do with mathematics as a subject while others hold certain perceptions and conceptions towards individual mathematical applications.

Lerman (1996:133) argues that there is no social life without meanings, as meanings drive the social interactions that sustain the social environment. This is in the sense that people interact not with the social environment but they interact with the meanings in the social environment which then prefigure how they act towards the social environment (Douglas, 1996:3). The social environment without meanings is therefore meaningless. The way students act towards mathematics is based on the meanings they attach to it. For example; Kloosterman, Raymond and Emenakor (1996:52) note that students who recognise the utility value of mathematics are more likely to be willing to choose it as a course even when given the option of opting out. They are thus acting based on the meaning attributed to the value that mathematics has for them.

The viewing of perceptions and conceptions as “means of expressing meaning” is Swidler’s (2007:273) proposition. It implies that conceptions and perceptions are a means to an end. This is in the sense that they express meanings of the patterns of social reality and through these meanings, interaction is made possible. Meanings also narrate a story about the social trends in society, such as patterns of meaning making processes and knowledge construction, patterns of social interaction and social relations and socio-cultural landscape of the social environment. The investigation of the array of meanings attached to mathematics by social science students as a social group is thus an act of mapping the connection that eventually

leads to a display of a pattern of shared narratives that provides insight on their mathematics performance.

By exploring students' conceptions and perceptions, one is tapping into students' pool of experience and the meanings attributed to mathematics. By tapping into experience, some factors that provide understanding on the causes of learning behaviour are uncovered. Through the array of meanings students attach to mathematics, we get a sense of who the students are, what they value, what their preferences are, how they view themselves as mathematics learners and so on. This is sociology's pursuit, to "look beneath the surface of things present and past, probe noteworthy silences to understand why things are how they are by revealing unseen connections" (Matthewman, West-Newman and Curtis, 2007:13-15).

### **2.3 Individual and Social Meanings**

People attach meanings to every social context they interact with. This they do either as individuals or as collective members of society. The ability to attach meanings to the social environment is one of the attributes that defines humans as uniquely human. Mathematics teaching and learning is also bound by the same principle of meaning making and meaning attachment.

Meanings can either be social or individual. Individual and social meanings can be viewed as a cyclic relationship of structure and agency that co-exist and reinforce one another. This assertion is supported by Giddens (1989:256) who states that "structure exists in and through the activities of human agents" and the relationship between agents' interactional processes and practices produce the structure of the social system. Social meanings denote the collective or shared interpretation of some social contexts within society. They shape and organise patterns of social relations in society. As Alexander (2003:13) asserts, social meanings are shared in society to ensure the continuity of the shared interconnectedness in society. Social meanings can be illustrated as follows. If a gesture is defined as rude in society, that rudeness is a social meaning; if an action is regarded as appropriate in society, that 'appropriateness' is a social meaning. Social meanings are thus the norms that govern what society defines as acceptable and unacceptable behaviour through predefined patterns of conduct (Lane 2001:294). Giddens however insists on the potential of humans to choose actions deliberately and carry them effectively in defiance of established rules and power

(Giddens 1984:14). The author identifies choice as the fundamental component of everyday living (Giddens 1991:80) which allows them the power of defiance.

Individual meanings on the other hand express the subjective and personal interpretation of social reality by persons. Conceptions and perceptions are individual meanings. They express individuals' independent, subjective and autonomous interpretations of social reality. What society defines as rude may not be interpreted as rude by some individuals and this sentiment can be shared by many other individuals in society. Conceptions and perceptions as individual meanings reflect agents' limitations and opportunities in that they not just constrained by their circumstances but also enabled by them to take certain actions (Lane 2001:298).

Sociology understands individual and social meanings to reinforce one another. Giddens' agency, structure debate (structuration theory) articulates this relationship quite clearly. That is, meanings as structure are simultaneously produced by individuals through human agency meanings, it values most the understanding of individual meanings as an outcrop of the social as well as how these meanings interrelate with the wider society. This follows that the understanding of individual meanings is only possible in so far as it is situated within the network of interconnectivity with other individuals (Hodkinson, Bieska and James, 2008:31). It is the social environment that provokes individual meanings and they not individually arrived at by an individual existing in a vacuum. It is therefore of utmost significance that the social science students' individual meanings attached to mathematics be traced back to the social nexus of interconnection of meanings attached to mathematics as a social group. "Although people are unique, they share characteristics with others sharing similar social positions, backgrounds and experiences" (Hodkinson, Bieka and James, 2008:15).

The investigation of individual meanings can be misinterpreted as deriving the social from an aggregation of individuals, warns Inghilleri (2005:128). It is however argued that "meanings can be viewed as either meanings of collectivities or collective aspects of individual meanings" (DiMaggio, 1997:274). The defining feature of aggregation is the element of disparity in the parts that define the whole. The study focuses on the social structure of meanings to which individual meanings are a member. (Inghilleri,2005:128). In other words, the individual is not the prime focus but the collective. This is because meanings as ways of understanding social reality transcend the individual and focus on the ways of conceiving and

perceiving the social world through the social structure of those meanings (Marton, 1981:195).

Students are probed as a deliberate attempt to acquire ‘inside information’ on their social realities as a collective so that the social world is understood, seen and interpreted through their eyes. This is endorsed by Anderson and Ozanne (1988:512) who argue that “if the social reality is based on individual perceptions then in order to be able to understand those perceptions, individuals must be involved in creating the research process”.

#### **2.4 Heterogeneity and Reflexivity-The Key Characteristic Features of Meanings**

Burton (2004 as quoted by Reid, Wood, Smith and Petocs 2005) argues that mathematics learning is a social activity and people attribute various meanings to social activities. This means that meanings are variable or not shared in the same way, as they are a product of culture (Cohen, 1985:14). The variability in meanings attached to social contexts links to the social constructivism theory which emphasises how student’s attach varied meanings to similar social contexts and how these individual meanings are reconciled in learning. This is also as advanced in Bourdieu’s notion of cultural capital which emphasises that various social relationships and networks offer an array of social and cultural know-how, skills and qualities which prefigure how individuals act or behave, and these are not equally distributed in society. This therefore means that the meanings attached to mathematics vary with different social contexts and this is the heterogeneity that Reid, Wood, Smith and Petocs (2005) allude to. The heterogeneity or variance in meanings attached to mathematics is the ‘conceptions’<sup>16</sup> aspect of mathematics.

Meanings as having the status of culture (Gerhards, 2005:4-8) and thus shared differently in society, implies that they are characterised either by compliance with the overarching shared meaning at one end or by contentions and differences to the shared meaning at the other end. In other words, compliance with the universal status of mathematics is one culture. Contention and difference to the universality of mathematics is another culture, provided it is a collective sentiment and characterises a particular group of people.

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<sup>16</sup> This is considering that conceptions are the varied ways by which individuals interpret social phenomena.

The benchmark for shared meaning is that for a social activity, social object or a symbol to be shared by members of society, that object, activity or symbol must be characterised by collective values and compliance. What we are currently experiencing with mathematics is a possible non-compliance in meaning for mathematics as a social activity by students. This is a deviation from the traditional definition of culture as characterised by uniformity. This expresses itself in the continued poor mathematics outcomes by students.

As already noted, Edling (2002:200) argues that mathematics performance is said to be characterised by “students’ inability to formulate and analyze thoroughly the mathematical interpretation about phenomena too complex to be handled in words”. This plays itself out as poor mathematics performance. This is in the sense that in mathematical applications, students do not demonstrate a level of mathematics proficiency<sup>17</sup> as expected especially at post-graduate level where Muijis (2004:3) states that “mathematical applications underlie quantitative research”. The possible difference in meanings of mathematics as expressed in mathematics outcomes can therefore be interpreted to be a potential contention of the dominant meaning or an emerging subculture of the dominant meaning attached to mathematics. Put differently, it appears that students act towards mathematics based on the meaning it has for them not the supposedly ‘shared meaning’ that emphasises mathematics’ universality and value. Notably, the inconsistency and contentious mathematics meaning linked with the poor mathematics outcomes are the heart of the study with reference to post graduate social sciences.

The Council of Higher Education (CHE) report (2011:4) captures the potential contention of the universality and value of mathematics especially by social science students as follows: “The pervasive presence of computers to carry out calculations has reduced the need for mathematics”. This sentiment has been confirmed to be a shared narrative among social science students in a study conducted by Gibbs (2010:1). It is in the interest of this study therefore to pursue the pattern of meaning that social science students attach to mathematics so as to link it to how it influences mathematics outcomes. Douglas (1996:14) notes that the meanings that students attach to mathematics vary according to the “nature of mathematical

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<sup>17</sup> Mathematics proficiency can loosely be defined as mathematical knowledge that students have and their ability to apply that knowledge in different contexts. The opposite is true for the lack of mathematics proficiency which implies that the student lacks the mathematical knowledge base thus is significantly handicapped in its application.

knowledge, character of mathematical activity and the essence of learning mathematics” as detailed in the literature.

Crawford et al. (1998) acknowledges that, due to the evolutionary nature of the social plane, people’s meanings to social contexts are not stagnant but change with changes in the social plane. The changes in meanings attached to social contexts according to Crawford et al. (1998) are a result of the individual’s ability to introspect the meanings attached to encountered social contexts and this leads to the construction of new meanings and the reconstruction of old meanings such that the meanings are not only heterogeneous but also reflexive. The evolutionary nature of meanings has been explained in the theoretical framework as advanced by Bourdieu.

The constant change in the meanings that students in particular attach to learning contexts has been endorsed by Chickering and Reisser (1993:51) who argue that in learning, students undergo a process of reflexivity or self-confrontation in their development or in new situations. It brings along new ways of viewing the world around them particularly the learning contexts. This may lead to students redefining themselves, as observed in a change in values, priorities, and beliefs including their perceptions and conceptions as highlighted in the theoretical framework. This is understood to mean that change in the ‘social landscape’ is one of the factors that lead to re-configuration of meanings. The reflexivity aspect relates to this study in establishing the trajectory in the students’ change in students’ conceptions and perceptions, if any.

## **2.5 Experience and Social Interaction in Prefiguring Meanings**

Crawford et al. (1998) acknowledge ‘experience’ as a key and socially significant variable in prefiguring the meanings people attach to social contexts. Experience alludes to social, institutional, cultural and historical contexts that one has encountered or is currently encountering. As Anderson and Ozanne (1988:511) asserts, “experience is an act of living through which meaning is dynamically created”. That is, meanings are a product of the ever-evolving social encounters from the past to present.

Crawford et al. (1998)’s contextualisation of experience refers to the ‘encountered world’ or prior experience as central to the understanding of why students conceive or perceive of



mathematics the way that they do. In other words, he is arguing that prior experiences prefigure the perception of future experiences. This assertion is endorsed by Sfard (2003:27) who also maintains that our thought processes are informed by our experiences of the social environment. Taking the argument further, John-Steiner and Mahn (1996:192) in quoting Valsiner (1987:6) argue that perceptions and conceptions come about as the individual interacts with the social environment and the cumulative history of these interactions constitutes the hierarchy that prefigures who one is and how one is bound to act. This assertion links with Bourdieu's theory where habitus is 'a structured structure and a structuring structure'.

Experience can also be interpreted as a historical narrative of social interactions. Crawford's acknowledgement of 'experience' therefore is essentially acknowledgement of the role of social interactions in influencing learning outcomes. This viewpoint has been supported by John-Steiner and Mahn (1996:192) who state that, when beginning an activity, learners depend on other people with more experience for assistance. Social interaction is thus the key variable in social exchange in the social environment. Interaction becomes both a plane (flat surface) in which social exchange occurs and the vehicle through which social exchange occurs, as noted earlier in the introduction. In other words, awareness of the social environment comes as a result of interacting with the social environment. Awareness becomes the raw product that is reflected upon and interrogated to develop individual and subjective interpretations and meanings (conceptions) about what goes on in the social environment<sup>18</sup>.

Turner (1988:15) defines interaction or interactional process as the process influencing one another's behaviour. Alluding to the interactional process as a process between people is a popular definition of social interaction. This study however argues that Turner's definition is misleading and a one-sided view as it accounts for only one aspect of social interaction in the social environment. It only accounts for the interaction between human beings. Building on the work of Mead (1934) on symbolic interactionism, human beings interact with self, symbols and society. That is, they do not only interact with the network of people around them, but they also interact with the meanings in symbols in society. This includes icons,

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<sup>18</sup> Reference is made to Leder, Pekoer and Toner, (2002:27and40) definition of conceptions as "the well thought meanings and interpretations that students attach to social phenomena based on one's personal experience with that social phenomenon".

shapes, and figures among other social objects in the social environment. Interestingly, people also interact with self (interaction between the 'I' and the 'me'). In other words, the 'social' in social environment is made up of individuals, groups of people and symbols among other things. Considering that perception and conception refers to meanings attributed to social phenomena such as human beings, forms, figures, symbols among others, this implies that this discussion is essentially about the attribution of meaning as a product of interaction with this network of social contexts. This is substantiated by Bourdieu's reference to the social environment as "an open system of dispositions" (Brochbank and McGill 2007:32) that people interact with. The social objects such as language, symbols, people and so on are positioned within this open system.

In applying this explanation to mathematics learning, students' perceptions and conceptions of mathematics as meanings is in part a product of social, symbolic and individual introspective mathematical interaction. In other words, a definition of interactional processes that only accounts for the cyclical interaction between humans does not suffice for this study. This is because mathematics learning is not only interaction with the people involved in the learning context but also interaction with symbols and interaction with self. This is because mathematics as Godino and Batanero (1998:3) assert, is a language of symbols and therefore mathematics learning is also interaction between the human habitus and the habitus of the field.

The significance of interactions with people, self and with symbols in mathematics learning is to acquire and share the mathematical disposition and to attribute individual meanings to mathematical operations. Patrick, Ryan and Kaplan (2007:86) state that interaction may involve student's participation in class activities such as in group discussions or one-on-one informal discussion. Whatever form of interaction is said to promote students' understanding of concepts, Patrick, Ryan and Kaplan (2007:86) further argue that the student who addresses or explains concepts to the others, benefits most in grasping the concepts. This has been referred to as 'learning by doing' in the literature.

Anderson (1988:514) in quoting Blummer argues that individuals act based on the meanings that they ascribe to anything and everything they interact with and the process of meaning attribution begins with social interaction. Symbolic interactionists advance that meanings arise from three dimensions of interactions, as follows.

### **a) Interaction with people**

This means that meaning is constructed through interaction with others as individuals or groups. The most influential group in social interaction is the family as the primary group or ‘significant others’. This is because it is from the primary group that the socialised self emerges and where the values that one embodies are acquired. In other words, not all people are equal in the power to shape our sense of self. This has to do with social conditionings being internalised by the student and becoming the basis upon which they attach meanings to the world around them once internalised or embodied. The process of internalisation is validated by Elder-Vass (2007: 334) in hypothesising that “when we internalize something, our beliefs about the world are affected by our experience in such a way that we accept what we have internalized as a fact”. In other words, the family is one of the social contexts from which the dispositions of habitus are acquired as advanced in the theoretical framework section.

Engelbrecht et al (2008:58) argue that in mathematics learning, failure is a cumulative and progressive problem emanating from a poor or weak mathematical foundation of early childhood learning through to higher education. In other words, the mathematical foundation (as a disposition) laid at early childhood learning has a structuring effect on consecutive students’ conceptions and perceptions of mathematics and the choices made regarding the subject in future. This affirms that students’ mathematical ability is an accretion of interactions with other people in society throughout their educational experience as detailed in the theoretical framework.

### **b) Interaction with symbols**

Mathematics is a medium of communication that utilises symbols in identifying problem situations and articulating solutions to those problems (Godino and Batanero, 1999:3). In doing mathematics therefore, students interact with the mathematical symbols and they attribute meanings to their interaction with these symbols. This implies that symbols are symbols because there is meaning attributed to them such that without the meaning the symbols would be meaningless.

### **c) Interaction with self/ Interaction within the individual**

Interaction with self emphasises that the process of meaning attribution is not only external to the individual but also internal. It is internal in the sense that the individual not only interacts with the people around them but that they also interact and converse with themselves. Interaction with self is introspective interaction. The significance of the interaction with self is that it explains how individual students' perceive their own ability in mathematics. There is a proven relationship between belief in oneself and educational success as it mediates between students and their schoolwork ( Middleton and Spanias 1999:67). The authors argue that students generally learn to dislike mathematics and that this dislike is a result of the meanings that students attribute to their mathematical abilities and this becomes their perception of themselves. Attribution of meanings about an individual's perceived mathematical capabilities is thus a result of introspective interaction with self.

Haggis (2003:94) has challenged the investigation of meanings in establishing social reality<sup>19</sup>. He argues that "meanings are extremely general and non-specific and can be interpreted in a variety of ways". The author also raises concerns about other life experiences that are not linked to study that may however influence students' perceptions and conceptions to learning (Haggis,2003:94). In countering Haggis's claims, I argue that it is based on the appreciation of the complexity of the social environment, the awareness of the 'broader realm' of meanings as well as the variance in meanings that people attach to the social environment that this study in particular investigates meanings not meaning. In light of the generality and non-specificity of meanings that Haggis (2003) questions, I argue that his concern would have been more useful if he had made suggestions of alternatives that are more specific, non-generic or non-generalist in nature, that could be used in place of meanings but serve the same purpose as meanings. Interestingly, Haggis continues to point out that methods of analysis lose favour when new ones are discovered as the new ones are generally an improvement of the former (2003:95). His very assertion is applied to address his concern on the continued use of meanings in light of the absence of such alternatives.

I interpret Haggis's (2003:94) concern on 'personal meaning tied up to life's aspects that do not relate to study' as a mere display of his inclination to the traditional psychological

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<sup>19</sup> Although his arguments specifically relate to deep approaches to learning, they can however be generalised to the investigation of meanings in general.

interpretation of reality. Traditional psychology tends to ‘gloss over’ the role of the social environment in prefiguring mind processes (Rubinstein, 2001:151). That is, it portrays mind processes to be independent of the social environment such that cognition operates in its own realm without any intersections with the very social realm that makes the individual thinker who he/she is (Vygotsky, 1962 as quoted in Wellington, 2010:132). The interconnectedness in social realities is a basis upon which meanings are constructed. Following the domination of the psychological explanation, Trowler (2005:17) notes that sociology has lost much ground to psychology to date in this area of study. This is one of the gaps that this study seeks to fill.

## **2.6 Theoretical Framework- Introduction**

What follows is a discussion of the two theoretical frameworks employed by the study. The significance of theoretical frameworks is their ability to interpret the interaction between individual and social processes in explaining social action. It follows that social action mirrors people’s social realities (Schartzki, 2007:97). In Bourdieu’s language, theoretical frameworks are instrumental in interpreting ‘social practice’. Social practice is conceptualised by this study as the sustained and continued interaction between agency and the structure in the creation of the social. It involves individuals’ engagement or interaction with social contexts and how individuals and social contexts influence one another as they collide, particularly in the attribution of meaning to the social world.

Social practice is also concerned with processes that are at the heart of social existence. These are processes that shape, structure, enable and prefigure social contexts in society as noted earlier, without which social life is impossible. Meaning making and meaning attribution to the environment around us is at the heart of social interaction and communication and therefore an uncontested necessity for the sustenance of social life.

One of the theories that this study engages is social constructivism. It is a follow up to Haggis’s (2003:94) assertion that “individuals interpret social reality in a variety of ways”. This assertion is applied to mathematics learning in understanding how the varied meanings that students bring to the learning environment are aligned to the mathematics way of knowing.

The second theory that the chapter engages is the French sociologist Pierre Bourdieu's theory of social practice. It provides an understanding of how conceptions and perceptions as individual meanings in particular are instrumental in understanding the poor mathematics outcomes under investigation. Borrowing from the words of Rubinstein (2001:1), Bourdieu "navigates us through the locus of social causation". Bourdieu allows us to explore a range of underlying processes that structure the interaction between the individual and the social. This is to understand how the variance in meanings attached to social phenomena comes about and how it prefigures differentiated social behaviour among individuals particularly in similar situations. The common ground between social constructivism and the theory of social practice by Bourdieu is that they both emphasise the significance of cultural contexts in informing social relations and how, through understanding these social relations, we understand our place in the social environment and make sense of various social contexts.

Bourdieu's critical contribution to the study is his attempt to find a balance between structure and agency in explaining social action. The structure/agency debate as already alluded to in the conceptual framework, concerns the interaction between the larger social processes and the individual in terms of how the individual and the social environment constrain, enable, inform and prefigure each other as they interact. Bourdieu's framework is thus adopted by the study to understand the interaction between individual students and social contexts and how social contexts shape the meanings that students attach to mathematics, and to establish the place of meanings in students' performance in mathematics. The discussion starts with a brief investigation of how Bourdieu's theory is used in education. This is to align Bourdieu's interpretation of the constructs of the social practice theory with his application of these constructs, particularly to education as the study involves mathematics learning as an aspect of the education system.

### **2.6.1 Social Constructivism**

Social constructivism is a branch of the constructivism perspective whose central argument as it applies to education, is premised on the claim that student conceptions of knowledge are derived from a meaning making process in which students engage in a process of constructing individual interpretations of their experiences. In other words, like any other social context that students attach meaning to, they attach different meanings to mathematics. Put differently, the constructivism perspective generally advances that, while mathematics may mean one thing to one student, it may be interpreted differently by another student based

on how it has been experienced by those individual students. This assertion has been endorsed by Naylor and Keogh (1999:93) in arguing that “students are not blank when they enter the mathematics classroom” but they bring with them ‘commonsensical’ interpretations of the mathematical applications.

Lerman (1996:147) states that mathematics education is “concerned with students acquiring the language and the concepts of the community of mathematicians”. This therefore implies that for students to succeed in mathematics, the individual meanings that students attach to mathematics have to be aligned with the institutional or mathematical way of knowing through the process of learning. Mathematics learning is thus an instrument through which the acquisition of the mathematical language is achieved.

Social constructivism argues that meaning is co-created among communicating groups. The co-creation of meaning between the teacher and student or between any other discussions among groups in mathematics learning explains how a temporary state of agreement in their class discussions is achieved as part of the learning process or in any other learning scenario outside of the classroom. It advocates for the collective construction of mathematical meaning considering that mathematics is a social activity that entails the acquisition of institutional knowledge. This argument has been substantiated by Bourdieu’s discussion of the ‘bounded’ nature of fields.

Constructivism and social constructivism are linked in that social constructivism builds on the foundations of constructivism. The distinction is that social constructivism goes further than dwelling on individual meanings to focus on how these individual meanings are synthesized in social interaction into the social structure of mathematical meaning. Kim (2001:4), in analysing social constructivism, identifies any form of learning and knowledge acquisition as a human activity and a social process that occurs (among many other ways) as individuals are engaged in interaction with one another and the social objects in the social environment. In other words, for consensus or for a ‘working interim’ to be reached in the process of engaging one another or of interacting among communicating groups, there is a process of meanings negotiation involved. This is where people develop shared understanding on common interests and assumptions as the basis for their interaction and communication. This process of meaning negotiation is referred to as ‘inter-subjectivity’ among individuals. ‘Inter-subjectivity’ or shared meanings are necessary in mathematics

learning because as Kim (2001:2) asserts, “Acceptable mathematical meanings are the ones that accurately mirror the mathematical representations of the social world”. Conversations among communicating groups are thus micro instances of social interaction which reveal how the members of the community daily and interactively encounter the wider culture (Falk and Kilpatrick 2000:6).

Social constructivism relates to the study in that it brings understanding on how the meanings that students hold are synthesised in the experience of mathematics learning resulting in a collective generation of meanings that are congruent with the mathematical way of knowing. Social constructivism is thus concerned with how commonsensical meanings that do not fit in the mathematics language social structure are traded, given up or made compatible with the mathematical way of knowing in mathematics learning. This is because learning is a cumulative process whereby students link prior learning experiences and knowledge with present learning situations (Naylor and Keogh 1999:93). Social capital is a possible outcome of the social practice of conversational interaction (Falk and Kilpatrick 2000:6), through the enhancement of human capital and such is the link between social constructivism and Bourdieu’s theory of social practice.

### **2.6.2 Pierre Bourdieu’s Theory of Social Practice**

To understand how poor mathematics performance is produced and reproduced, we need to first understand students as agents and the nature of fields, particularly the social science field as the key field in the investigation. Such understanding is instrumental in further understanding how fields and agents interrelate. It is through the understanding of this interrelationship that we then establish the place of meanings and how they prefigure how students as agents act towards mathematics. Bourdieu’s theory of social practice provides us with theoretical constructs that help us understand how this happens in practice.

The habitus, capital and field are the analytical instruments in Bourdieu’s theory that explain how the social environment shapes and prefigure the meanings that individuals attribute to aspects of social reality around them. In other words, the theory establishes how the social environment conditions ‘predispose’ students to view mathematics in ways that are either commensurate or incommensurate with the mathematical or institutional way of knowing. This is based on the premise that the various social environments that individuals interact



with, inform the various and differing meanings that people attach to social contexts so that meaning becomes an outcrop of culture (Gerhards, 2005:4-8).

In the attempt to bridge the gap between objective structures and students as agents in understanding differences in mathematics performance, a link between phenomenography and Bourdieu's habitus construct is established. The link is the convergence between individual experience and the objective social structures in the process of meaning attribution. The starting point in the discussion of the individual constructs in Bourdieu's theory of social practice is to look at how Bourdieu's theory of social practice is used in education.

### **2.6.3 How Bourdieu's Theory is used in Education**

Bourdieu's theory of social practice offers a framework for the systematic investigation of inequalities in educational attainment. It focuses on micro- and macro- sociological explanations of the causes of differences in educational attainment. Bourdieu conceptualises the reproduction of inequalities in educational attainment as a cultural reproduction based on class membership (Sullivan, 2002:144). He uses the habitus, field and capital constructs in advancing his arguments. He interprets the habitus to be an internalised pool of knowledge that provides a basis for students' behaviour towards school. The meanings that students attach to mathematics in Bourdieu's language can thus be interpreted as 'schemes of knowledge' that influence how students behave towards mathematics. The pool of knowledge is acquired through interaction with various social environments that possess these traits, particularly those environments that are rich in a dominant culture, ultimately associated with the upper class (Sullivan, 2002:144). Students' performance in mathematics is thus a result of individual students' habitus as it interacts with the education system.

Ritzer (2003) notes that the political field has a structuring effect on other fields including the education system. This has been observed in how politics influenced the direction and nature of the RSA education system during the apartheid era and how it continues to structure the education system presently through curriculum reforms, in giving a few examples. This is as detailed in the literature. Below is a discussion of the habitus, field and capital constructs as applied in understanding the poor mathematics performance under investigation.

#### **2.6.4 Habitus**

The significance of the habitus construct in understanding the differentiated students' performance in mathematics and poor mathematics performance in particular is that it sheds some light on what motivates human action? Through the habitus construct, a link between culture, power and structure in providing an explanation of the systemic reproduction of inequality in the education system is established. Habitus is thus the power of agents to influence social structure. This is as discussed in the capital and field constructs below.

Bourdieu (1998a:81) defines habitus as a “socialised body, a structured body, a body which has incorporated the immanent structures of a particular world or field and which structures the perception of that world as well as action in that world”. In other words habitus is one's being and is expressed in how one acts in social situations. It is expressed in people's actions such as choices' preferences and how one carries one self such as “walking, talking, ways of feeling and reasoning” (Bourdieu 1990a:70). Does this mean that human action follows a predictable pattern of behaviour? Bourdieu, (1990b:78) notes that although habitus is an embodiment of the social which is then expressed in actions, it only “pre-disposes individuals to act out what they have internalized from past experiences but does not ‘determine’ them to do so”.

Swartz (2002:63S) asserts that, the dispositions of habitus are not automatically part of habitus but there is a process of acquisition involved for these ‘building blocks’ of habitus to be part of habitus. As Swartz (2002:63S) argues, it is through the process of social interaction between the individual and the social environment that the process of acquisition of dispositions occurs and it is not inborn. This includes interaction with other humans and interaction with social objects such as the mathematical symbols among others, as detailed in the second chapter. This therefore implies that since social interaction is a continuous process, so is the process of change or configuration of habitus. That is, habitus changes with the changes in the social environment.

Habitus is also structured in line with the cultural capital that exists in the social environment that it is a product of and lacks cultural capital that has not been part of its building blocks Bourdieu (1990a:54). Such connectedness in the history of interactions that informs habitus is what Bourdieu refers to as a ‘structured structure’ (Rubenstein, 2001:82). The continuous

meaning construction and meaning attachment process therefore translates to the continuous shaping and reshaping of self with every social interaction.

Bourdieu (1990b:91) notes that habitus is not only an accumulation of past, existing and future experiences but also a collective history of family, social class that the individual belongs. The author identifies early childhood experiences as crucial in structuring habitus. This therefore implies that family socialization forms the basis upon which subsequent socialization builds on in structuring habitus.

Brochbank and McGill (2007) state that people whose habitus is made up of 'similar dispositions' possess a similar outlook on life and this prefigures them to similar ways of behaviour. Similar dispositions are the shared social experiences that individuals encounter during their day-to-day interactions from which they acquire similar know-how of the social environment. The study interprets this claim based on the study's emphasis on conceptions and perceptions as meanings and as a product of culture. People who share a culture have a similar view of the world. Bourdieu (1990c:46) however notes that although people with similar social conditionings may display similar behaviour, no two similar habituses are identical and such is the structuring effect of habitus as a "structuring structure". Bourdieu (1990b:82) states that the dispositions embedded in an individual's habitus prefigure that individual's sense of place in society. The sense of place relates to what the individual capabilities and knowhow are and in which class social structure they are valued as habitus interacts with the cultural capital one possesses.

Reay (2004:435) notes that the limitation with the habitus construct is that Bourdieu makes no mention of how habitus is differentiated by race. The author notes that although that may be the case, it is possible to develop an understanding of habitus as shaped by race and gender. It is for that reason that a race and gender discussion is included in the literature review.

The study uses Bourdieu's notions of cultural, economic and social capital to establish the place of the varied meanings attached to mathematics in differentiated mathematics outcomes, particularly the continuity in students' poor performance in mathematics and the social dynamics involved in the production and reproduction of such inequalities. The capital constructs shed some light on how it is possible that students in similar mathematics learning

situations and similar social contexts however produce different mathematics outcomes with some proving to be mathematics proficient while others are not as well as how this trend is reproduced. The discussion on capital also helps us understand students' educational preferences in particular and the educational choices they make. This links to the research question on how students' conceptions and perceptions of mathematics impact their choice of research method for their studies.

#### **2.6.4.1 Cultural capital**

Cultural capital is concerned with how dispositions as embedded in habitus predispose individuals to certain ways of perception and conception or to certain ways of viewing the social environment and certain ways of acting towards social contexts. Lamont (1988:156) argues that the cultural capital or the combination of dispositions that people acquire from the social environment determine their sense of place in society by aligning them with society's dominant or subordinate culture as prefigured by social class.

Dominant culture has been defined by (Lamont, 1988: 156-157) as “the institutionalized, widely shared, high status cultural and most valuable cultural practices”. Dominated culture on the other hand refers to the less valuable cultural practices and signals in society. Mathematics can be said to be occupying a central place in the dominant culture in society because of its status as a universal subject and its value in social, economic and other aspects of development. This follows Krauss's (2005:763) claim that the universal status of social objects, including the status of mathematics, is their life-encompassing nature and their nature as ‘world views’. It is suggested that mathematics' central position in the dominant cultural status particularly in academia is confirmed by its position as a qualifier to educational ‘privilege’ or its status as passing subject, of course alongside English for some countries.

Mathematics receives a central position in the dominant culture status because some people assimilate to its universal status and its life-encompassing value and thus subscribe to it. Since ‘values and meanings as a product of culture are not shared in the same way’, there are those who do not assimilate<sup>22</sup> to its centrality in the dominant culture. Deviation from the main culture is in itself a culture. This is affirmed by Middleton and Spanias (1999:67) who

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<sup>22</sup> Assimilation is the “process by which minorities gradually adopt patterns of the dominant culture” (Macionis, 2007:339).

challenge the status of mathematics success as a master factor to social and economic development as Anthony and Walshaw (2009:6) claim. By mathematics receiving a central place in the dominant culture makes those that do not assimilate to its dominant culture status, a sub-culture or dominated culture. The questions then are: Is the emerging prominence in mathematics failure a suggestion that such failure is assuming a dominant culture status so that educational standards should be adjusted in assimilation to this culture of mediocre mathematics performance? Is it a must that sub-cultures should assimilate or can the dominant culture and sub-culture exist alongside one another? These are however questions that can be addressed by other related studies.

The fact that poor mathematics proficiency has been echoed even in higher education, renders the social science discipline as fertile ground to establish what the meanings that the students attach to mathematics are due to its diversity in students. Swidler (2007:275) argues that no matter how homogenous people may be in terms of shared aspirations and values, “the way culture construes the patterns of their social behaviour remains profoundly heterogeneous”. That is, although there is a possibility that social science students share some values and aspirations, the cultural tools embedded in their habitus as a result of their varied collection of experiences, makes their interpretation of social situations profoundly different.

Having noted earlier that society is predominantly cultural, culture provides a “toolkit from which people can construct diverse strategies of action”<sup>23</sup> (Swidler, 1986:284). Culture provides a range of possible options that students are likely to enact towards mathematics. Meanings as a product of culture prefigure individuals to behave in certain ways and not others. Swidler (1986:284) argues that for one to select how to act in a given situation, there has to be a meaning attached to that social situation; and the individual acts based on the meaning attached to that particular social context. This is understood to suggest that there is a certain combination of dispositions that a student needs to possess as acquired from the social environment as “an open system of dispositions” (Brochbank and McGill, 2007:32), for them to be classified as competent in mathematics. This follows from mathematics’ ‘bounded’ or ‘institutionalised’ nature, where the when and how to do things in the field has been predetermined by the field such that the field punishes a display of the preferred cultural capital.

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<sup>23</sup> Swidler (1986:284) defines strategies of action as the ‘characteristic repertoire from which individuals build lines of action’.

This can be exemplified as follows. Students who view mathematics as hard have acquired cultural capital from which they construct this meaning and this meaning prefigures them to perceive mathematics that way. It is thus natural for these students to accept that they cannot do mathematics and the opposite is true for students who perceive mathematics as do-able. This has been confirmed by Crawford (1994 as quoted in Houston 2010) who states that university students who conceive mathematics as bits of unrelated operations adopt a surface approach to learning, as highlighted in the literature.

McGrenere and Ho (2000) use the concept ‘affordances’ to support Swidler’s (1986:284) claim on how meanings provide a range of options on how students are likely to act towards mathematics. Affordances of the environment are what the social environment offers the individual student to utilise in everyday life. This includes everything that is at the individual student’s disposal in the social environment such as social meanings, knowledge and know-how, values, beliefs, culture, social artefacts and so on. McGrenere and Ho (2000:1) assertions are adapted to the study for further clarity on how dispositions predispose us into certain ways of perceptions and conceptions, as follows.

One kind of ‘affordance’ that mathematics is to individual students is its perceived usefulness. This is a product of the culture that individual students have experienced and it varies with individual students. For instance, a chair may be perceived by one to be for sitting on while another may perceive it as something to step on to reach for something in a top shelf. In other words, the chair in question has been perceived differently by different people based on its use value. That is, the affordance of sitting exists for one actor yet the affordance of stepping exists for another actor for the same chair such that the affordance is a result of the individual’s foresight in meaning attribution<sup>24</sup>. Likewise, mathematics is the kind of affordance that the individual student is able to perceive as dependent on individual student’s experience and culture (McGrenere and Ho 2000:2).

The universal status and the value that society ascribes to mathematics has made mathematics to receive a central position in the dominant culture that “sets out an exclusivist function” in

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<sup>24</sup> Example adapted from McGrenere and Ho (2000:1) example of a hard surface in advancing Gibson’s (1979) view of affordance.

using Lamont's (1988) phrasing. That is, not all societies have an equal supply of the mathematical disposition in their stock or in their unlimited pool of dispositions. This statement is endorsed by Gaddies (2012:6) who argues that not all households are equally privileged to succeed in mathematics. A student's possession of the mathematics disposition depends on one's social class, background, and race among other attributes as advanced by (Macionis and Plummer, 2007: 649) which places one at an advantage or disadvantage in mathematics learning.

The exclusivist function that mathematics sets out organises society based on the possession or the lack of the mathematics disposition. Such social organisation is played out in the social division of students who do not do well in mathematics, pursuing some majors and courses and not others. Lamont (1988) refers to the type of exclusivist function that mathematics executes as "over-selection". This according to Lamont (1988:159) is where "individuals with less valuable cultural resources are subjected to the same type of selection as those who are culturally privileged and have to perform equally well despite their cultural insufficiency, which in fact means they are asked to perform more than others". In mathematics learning, 'over-selection' can be said to refer to the education system's tendency to require all students to perform well in mathematics as communicated by the status of mathematics as a passing or failing subject. This is regardless of students' unequal chances and educational backgrounds lacking the mathematics disposition (Bourdieu, 1977:494). Mathematics learning requires meanings that are congruent with the "institutional practices of mathematics education" as Jorgensen (2008:3) asserts. This emphasises the possession of cultural tools in the form of meanings that are congruent with the mathematical way of knowing.

Meanings that are not congruent with the mathematical way of knowing have been identified by Liljedahl (2005) as "conceptions associated with mathematics being 'difficult', 'useless', 'all about one answer' or 'all about memorizing formulas'". As Swartz (2002:65s) asserts, students who lack the mathematics habitus naturally accept that mathematics is not for them. These students lack the appreciation for mathematics and thus fail the subject. Meanings that are congruent with the mathematical way of knowing have been identified by Anthony and Walshaw (2009:11) as language, reading, listening skills, ability to cope with complexity or resilience, and learning by doing, as some of the existing competencies that academically disadvantaged students possess. These according to Anthony and Walshaw (2009:11) become resources to build upon in a mathematics class. Macionis and Plummer (1997:649)

also consider ‘willingness to know things’ and a positive attitude as valuable cultural capital in learning. In agreement with Macionis and Plummer; Anthony and Walshaw (2009:8) further maintain that “students are to develop a positive attitude to mathematics and that a positive attitude raises comfort levels and gives students greater confidence in their capacity to learn and to make sense of mathematics”. Students in possession of the valued mathematical capital find the school cultural context as not intimidating (Macionis and Plummer,1997:649). This emphasises the role of the social environment in imparting such dispositions to students, as probed by the research questions.

Liljedahl (2005:224) reveals how an overwhelming majority of the students interviewed for his study attest to the fact that the change in their perception and conception of mathematics came about as a result of their willingness to apply themselves and to learn by doing, which made them appreciate mathematics more.

Bourdieu (1986:244) considered the involvement of the family, particularly parents’ involvement in students’ learning, as the best contribution to children’s academic success. Masten et al (1996:211) supports this proposition by maintaining that the apparent significance of parental involvement in education, such as monitoring and helping with homework, attending school functions, communicating strong educational values and conveying the value of effort and reading habits, is a recipe for their children’s school success. This relates to the study in establishing the role of their immediate families as one social attribute that is key in the prefiguring of what students value. However, parents have varying and differing views on what their roles in their students’ learning is, including their contribution to their students’ success in mathematics. Cheadle (2008:2) argues that “these different perceptions lead parents to endorse disparate patterns of educational investment that result in a stratification of life experiences, producing educational inequalities”. This explains why all families are not placed in an equal position to transmit mathematical capital domestically. This is in line with Haggis’s (2003:94) assertions that “the social ties up with many of life’s aspects that are not closely connected to study in explaining learning outcomes”.

Swindler (2007:274) argues that culture prefigures people to act in certain ways and not others and that “one can hardly pursue success in a world where the accepted skills, style and informal know-how are unfamiliar”. Conceptions and perceptions that one embodies as



culture also predispose one to certain preferences, values and choices. People do well in areas or social contexts where they possess the required cultural know-how (Swindler, 2007:274). This assertion addresses the study's research question on whether students' conceptions and perceptions of mathematics influence their research method. Students' interpretation of the world around them determines how far they would go, what they can and cannot do, the choices they would make, the risks they are willing to take, boundaries they are willing to transcend and so on, in achieving their academic goals. In support of this idea, Swartz (2002:63s) states that people internalise basic life chances available to their social milieu. People internalise their chances of success or failure and display their internalised potential and capabilities in their aspirations, preferences, expectations or choices. Despite the fact that the research method used by students is supposed to be determined by the kind of study undertaken, the study will explore the extent to which students' preference of either qualitative and quantitative approaches is expressed in their choice of research method for their research.

#### **2.6.4.2 Social and Economic Capital**

Bourdieu (1986:88) defines social capital as 'relational power' or the collection of actual or likely resources that exist within an interconnection of shared relationships. That is, social capital is not possessed by or vested in individuals but structured through patterns of social interaction and thus should be assessed in terms of those structured patterns of interaction. People or students to be specific are oriented in these social networks based on their engagement in these social networks of mathematics learning. These social networks therefore become responsible for the transmission of mathematical knowledge and expertise among and between student groups and individuals in applying Granovetter's (1973) words to the mathematics context. This essentially means that, although social capital is not possessed by individuals, the acquisition of mathematical knowledge and expertise through the structured patterns of interaction that are mathematics orientated, human capital is enhanced through these engagements. The cause and effect arrow can go both ways, it is noted.

Having access to those dispositions by being a member of a social group therefore implies that an individual can internalise some of the dispositions that exist within the group. This relates to the study in that a student's social background, such as family or school, may be

deficient in the mathematical disposition but by being a member of a study group for instance, the student gains some of the mathematical know-how, skills and qualities that may exist within the group.

Bourdieu (1986:89) argue that the more socially integrated an individual is, the greater the amount of social capital and the greater the chances to mobilise capital within the network. In other words, social capital is also about who one knows. This is to say, the more socially connected a student is, the greater the chances of benefiting from the mathematical know-how that runs within the network of interactions. That is, the wider the social network one is affiliated to, the greater the chances of ‘rubbing shoulders with’ or interacting with people who possess the disposition that is shared among the group. For instance, a student may be a member of a mathematics club, a study group and so on and from these he/she benefits mathematically.

Coleman (1988:110) confirms that social capital within the family is important for the intellectual development of children as it allows children to access parents’ human capital. The author however notes that this dependent on whether parents have a strong relationship with their children such that children are given attention or whether the parents are physically available for the children which mainly pertains to family structure( Coleman 1988:111)

The study notes that the arguments around social capital tend to be functionalist in nature. The study views this as a challenge since it implies that the construct is incapable of grappling with the diverse complexities of social reality which is characterised by among other factors; disagreements, divisions and conflicts.

Dika and Signh (2002:23) establish a link between social capital and economic capital. The authors argue that the more socially integrated a student is, the greater the chance of mobilising financial resources from the group of people one interacts with. The study understands financial resources to be both physical and symbolic. Symbolic financial resources refer to the qualities and skills that a student can acquire from the network of social interactions including qualities like motivation, language, reading, listening skills, ability to cope with complexity or resilience, being hardworking, and learning by doing as cultural capital (Douglas, 1996:14; Anthony and Walshaw 2009:11). Considering that cultural capital

can be converted to economic capital, the student may then utilise these qualities as a medium of exchange or a 'financial resource' to acquire the mathematics disposition. The physical financial resource is that a student can mobilise money from among his/her network of relationships to sustain them while they study.

### **2.6.5 Field**

Swartz (2002:65S) points out that the field is the social plane or social sphere where habitus generates social action. It is in fields that the connection between action of habitus, the structures of modern society and cultural practice take place. Structures of modern society include institutions, social class, education system among others.

Fields have also been defined as "arenas of struggle in which individuals and organizations compete, unconsciously and consciously, to legitimise those forms of capital which they possess" (Benson, 2006:190). They are responsible for the circulation or sharing of a particular kind of capital and they have agents trusted and allocated by the field to protect the interests or doxa<sup>25</sup> of the field. These according to Mois (1991:1022) are "the wielders of the symbolic power of the field and they struggle to relegate challengers of the field to the position of subordination". In essence, there is a production and reproduction of power at play within the field. Fields also have preferred habituses that are specific for or unique to particular fields. These habituses are aligned to what is valued in that particular field

"Each field generates its own specific habitus and one's success in a particular field depends on how the dispositions of his/her habitus such as their way of thinking, skills, way of acting and so on is aligned with the identifying features of that field" (Swartz, 2002:65S). The question then is how do fields as stratified systems of hierarchy of domination persist and reproduce inter-generationally without any resistance from agents? Bourdieu argues that the answer lies in the hidden power relations or dimensions between individuals, groups, institutions, cultural practices and processes that lock people into reproducing patterns of domination (Swartz 1997:11). Fields are able to neutralise people to accept the taken for granted operations of the system by "imposing their established order as natural through masked systems and mental structures objectively adjusted to the social structures" (Bourdieu 1979:82). In other words, there is an element of power at play within fields where the field as

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<sup>25</sup> Doxa is society's established social order that naturalises its inadequacies and unfairness (Mois 1991:1022).

a system has power through the curriculum as a codified form of knowledge to produce pedagogic identities and power on what accounts as acceptable knowledge within the field. These symbolic forms of power have been referred to as classification and framing (Ensor and Galant 2005:288)

Moi (1991:1022) notes that, for a field to work, “there must be people equipped with the habitus of the field which enables them to know and recognize the immanent laws of the game”. The author further notes that the people who are equipped with the habitus of the field hold different positions in the field and their hiatus is informed by different social conditionings. As a result, “they do not all play the game in the same way although they mutually demonstrate and recognise the rules of the game” (Mois, 1991:1022). In applying this explanation to mathematics learning, it can be said that the education system leadership including professors and or lecturers among others are the custodians of the fields ‘immanent laws of the game’ and protect the taken for granted practices in various fields.

Grenfell and James (2004) state that; “Every field is bounded or has its own rules and standards that govern its operations, including what is accepted as legitimate knowledge within that field”. It is suggested that mathematics as an entry requirement to some disciplines (pure sciences for example) suggests the standards and valued capital within those disciplines as well as a habitus that can compete successfully within that field. Such is the ‘exclusivist function’ in using the words of Lamont (1988:159) that mathematics plays within the field of education. This is in the sense that students pursue disciplines for which they have the cultural capital and this divides society based on possession or lack of the mathematics disposition and this division is continually reproduced.

The act of students aligning themselves with courses and disciplines that suit their abilities and preferences is said to be a ‘structural orientation’ by Rubinstein (2001:195). In this case the minimal mathematical requirement in the social sciences compared to pure sciences can also be said to be a structural orientation that spells out the valued competencies in the field. It seems that the entry requirements are structured congruently with the society’s distribution of capital, and mathematics acts as a filter or the currency that determines which field of study each individual student can pursue.

## **2.4 Conclusion**

The chapter has outlined the study's interpretation of conceptions and perceptions from a sociological point of view. This is to configure the reader's interpretation of conceptions and perception so that it is aligned with the study's sociological interpretation. This discussion is to create consistency in understanding the instrumentality, nature and the life of meanings and how it is used in this study, following the inherent cognitive psychological connotation that these concepts are immediately identified with. The study interprets conceptions and perceptions as meanings and it also establishes the place of conceptions and perception as a product of culture and social class. The study asserts that conceptions and perceptions as an outcrop of culture and a classed habitus underlies the continued students' poor performance in mathematics in that even though groups or individuals may value the same ends, but only some have the cultural resources to actualise them .

Two theoretical frameworks, namely, social constructivism and Bourdieu's theory of social practice in understanding the continued poor performance in mathematics in mathematics, have also been explored. Culture and social class has been found to be central in establishing each student's position in the mathematics field by prefiguring how students conceive and perceive the world around them and by prefiguring which lines of action they are likely to pursue successfully, based on the competence of their habitus in certain fields and not others. Social constructivism has emphasised the significance of 'negotiation of meaning' so that there is 'consensus' on mathematical knowledge as well as alignment of the individual meanings to the socially agreed on mathematical meanings. It also emphasises the enhancement of human capital through the process of meaning co-creation.

## CHAPTER THREE: REVIEW OF LITERATURE

### 3.1 Introduction

The investigation students' conceptions and perceptions is a much researched area in education research. The literature includes research in the area of students' conceptions and perceptions even at higher education. Students' conceptions and perceptions of mathematics is one of the popular methods of analysis through which mathematics outcomes have been interpreted in recent years (Trower, 2005:15). It is also gaining popularity in RSA research circles as observed in recent RSA journal publications. The investigation of the conceptions and perceptions approach is a product of an era where learning outcomes are investigated and interpreted based on the deep-seated meanings students' attach to their individual experiences with learning. The investigation of conceptions and perceptions of specific subject matters is premised on the realisation that conceptions are 'contextual' in nature and that they cannot be generalised (Entwistle, 2004:412). Mathematics learning is thus the context within which the study investigates students' conceptions and perceptions.

This chapter is a discussion of literature that relates directly to the study as guided by the research questions and the problem statement. The chapter begins with a discussion of the varying ways by which mathematics students have been found to conceive or perceive mathematics. As highlighted in the introduction, studies on students' conceptions and perceptions use either of the concepts and not both and such is still relevant information for the study. This is followed by a discussion of the perceptions of the learning environment, after which is a discussion of the conceptions of learning and knowledge to establish an understanding of the analytical tools that underpin the investigation of student's perceptions and conceptions of mathematics as we know them. The key factors that influence the way students perceive and conceive mathematics are established. Particular attention is then given to students' conceptions and perceptions of mathematics. The chapter concludes with a brief discussion of the structuring affect of the history of mathematics learning in the Republic of South Africa and the state of mathematics outcomes in SADC (Southern African Development Community) countries in general. The general state of students' performance in mathematics in SADC countries is incorporated into the discussion in order to accommodate the demographic diversity of post-graduate students that encompasses both South African and international students at the University of KwaZulu-Natal.

As already noted, students' conceptions and perceptions of mathematics are investigated with a view to exploring and understanding poor mathematics performance, particularly by social science students, bearing in mind Zettle's (2003:200) observation that most students enrol for the social sciences with the hope that there is little or no mathematics at all. Exploring and understanding poor mathematics performance is in pursuit of the improvement of students' mathematics learning outcomes. The improvement of students' learning outcomes has been the primary focus of studies on students' conceptions and perceptions of mathematics from the late 1970s to the present. The need to focus in the enhancement or improvement student learning outcomes is as a result of observed discrepancies in students' performance in mathematics that have characterised the education system. Improved mathematics outcomes are thus an overall goal of education. This claim is advanced by Swindler (2007:274) who argues that social systems are driven by the achievement of their core objectives and values. The study's investigation of the "lack of mathematics proficiency by social science students" (Edling, 2002:200) is aligned with goal three of UKZN's 2007-2016 strategic plan that emphasises pre-eminence in research as the institution's objective.

### **3.2 University Students' Conceptions and Perceptions of Mathematics**

The key question in establishing students' conceptions or perceptions of mathematics is 'What is mathematics?' Marton (1981:178) notes that "any answers to questions that seek to solicit people's understanding, meanings and interpretations of social phenomena are statements about people's conception of reality". The variation in meanings attached to this question is thus interpreted as perceptions and conceptions. This is because internalised knowledge and meanings attached to social phenomena are expressed in speech or utterances. In Bourdieu's language, the embodied immanent structures of the world are expressed through a variety of activities including speech and walk among others (Bourdieu 1990:70). Such is the basis upon which inferences about students' history of interactions and the meanings attributed to social contexts and aspects of their mathematics reality is drawn on as conceptions and perceptions.

Douglas (1996:12) identified three major themes upon which students' conceptualise mathematics. These themes have been found to relate to the kind of social object or social

activity or ‘affordance’<sup>26</sup> that mathematics is to individual students. The author argues that the way students conceive mathematics ranges from the nature of mathematical knowledge, the character of mathematical activity and the essence of learning mathematics. Such is the continuum within which Douglas (1996) has found students’ meanings attached to mathematics to range. Outlining the various aspects of how students conceptualise mathematics is thus a guide in our understanding and interpretation of students’ meanings and interpretations of social situations in their dynamic interactions with the socio-cultural context in which they are embedded (Volte, 1999:628). Douglas has found students to conceive or perceive mathematics as follows.

### **3.5.1 The nature of mathematical knowledge**

This is where mathematics knowledge is conceptualised in terms of its composition, structure or its status. Three sub-themes are identified by Douglas (1996:12) under the conception of the nature of mathematical knowledge and these are:

- i) *Composition of mathematical knowledge* - includes the representation of mathematics knowledge, formulas and algorithms. This conception according to Reid et al (2003) is where students view mathematical activity such as numbers and calculation and make no essential advance beyond elementary arithmetic.
- ii) *Structure of mathematical knowledge* - entails interpreting mathematics either as consisting of interlinked content or as a collection of a variety of content that is unrelated. This is where mathematics is conceived as consisting of methods and applications that are not related and as having no meaningful use in everyday life (Reid, Wood, Smith and Petocs, 2003).
- iii) *Status of mathematical knowledge* - entails students defining mathematics either as a rigid entity or as a dynamic field. This is where students view mathematics as ‘rule-like’ and as having no room for creativity such as applying the law of gravity.

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<sup>26</sup>Refers to what the social environment offers the individual student. This includes everything that is at the individual student’s disposal in the social environment such as social meanings, knowledge and know-how, values, beliefs, culture, social artefacts etc (McGrenere and Ho, 2000:1).



### **3.5.2 The character of mathematical activity**

Douglas (1996) states that students also conceptualise mathematics as an activity; either as “*doing* mathematics or *validating* established mathematical ideas”. Doing mathematics is a process that involves one embarking on a journey of finding things out or discovery through trial and error. Dossey (1992:45) argues that learning mathematics actively by ‘doing’ encourages learning the skills of the discipline through a deep approach to learning. He argues that learning by doing encourages students to see mathematics as having a worth in their lives. This has been substantiated by a study conducted by Liljedahl (2005:220) which maintains that there is a change in perception from negative perceptions to positive perceptions about mathematics that comes with making an effort to engage with mathematical operations. Liljedahl’s (2005:220) states that the negative public narrative about mathematics being hard is challenged as students discover solutions to mathematical operations by aggressively engaging themselves. He defines it as an ‘AHA! moment’, or a moment of self discovery, an eye opener and beliefs alteration about their mathematical abilities. Lerman (1996: 137) argues that know-how or any skill is acquired through practice and not imparted or transmitted. Likewise mathematical knowhow comes about with practice.

Validating ideas is where students conceive of mathematics as a process that was discovered by the ‘knowledgeable others’ of the field so that the role of the student is just to reproduce the solutions that were discovered. Douglas (1996:14) argues that a student who conceives of mathematics as validating ideas looks forward to being assisted by others with mathematical applications and makes no effort to discover solutions through independent trial and error. This confirms Kloosterman, Raymond and Emenakor (1996:40) findings that most “students believe that the goal of mathematics is to get the right answers and that the role of the student is to receive the mathematical knowledge and teachers are transmitters of the knowledge”. Haggis (2003:99) defends the portrayal of validating ideas as completely negative, arguing that students have varying academic developmental capabilities and validating is a starting point.

### **3.5.3 The essence of learning mathematics**

This theme according to Douglas is where mathematics learning is perceived as constructing knowledge so that knowledge develops from memorising to application to construction of

new knowledge. The essence of learning mathematics has been outlined as a developmental pattern in which the knowledge construction and knowledge memorisation are stages in the mathematics knowledge development continuum which students have to demonstrate as they progress through their educational trajectory. This is what Haggis (1996:98) refers to as 'stage theory' because it perceives the development of knowledge to be in developmental stages.

### **3.5.4 Life conception**

This pertains to students making a connection between the mathematics learned in class and their day to day tasks activities (Reid, 2003). It is where mathematics is viewed as a way of life and a way of thinking and in life conception, the learners make strong personal connections between mathematics and their own lives and view mathematics as useful. Douglas (1996:15) argues that the perceived usefulness or value of mathematics is a key determinant of whether students pursue mathematics or not. The value of mathematics relates to the kind of 'affordance' that mathematics is to the individual students as highlighted in the theoretical framework. This viewpoint is supported by Dossey (1992:45) who states that the relevance of a subject for a student is its utility value or perceived usefulness in everyday life and future. Dossey (1992) asserts that the utility value of a task is a significant factor in why someone would want to stay attached to that task. This statement is affirmed by Kloosterman, Raymond and Emenakor (1996:40) who state that for students to put an effort into what they are learning, they would have to realise its value. The emphasis of students' advancement in their conceptualisation of mathematics to a level where mathematics is conceived as a way of life (Reid 2003), is an imprint of Entwistle's (2004) conception of the 'stage theory'.

Does Douglas's (1996) analysis of how students conceive and perceive mathematics imply that human behaviour is predictable? McLeod (1992:581) cautions against the conceptualisation of the meanings that students attach to mathematics according to Douglas's (1996) suggestion as a blue-print approach, suggesting that the meanings that students attach to mathematics are not one dimensional. McLeod (1992) argues that "there are many different kinds of mathematics as well as a variety of conceptions about each type of mathematics". He further argues that meanings that people attach to social contexts arise from two different backdrops. One is as a result of invoking a repeated negative or positive experience which was perceived negatively or positively. Second is the attribution of an

already existing conception or perception to a new but related task. For instance; a student who has a negative conception or perception to mathematics may attribute the same meaning to statistics or any form of quantitative research. In other words, Douglas's framework on students' conceptions and perceptions is a guide in our understanding but not cast and stone.

### **3.3 Students' Perceptions of the Learning Environment**

The investigation of students' perceptions of the learning environment looks at students' learning outcomes as influenced by the totality of activities that take place in the learning environment. This is because social practice does not take place in a vacuum but a social context and the social context in this case is the interaction between human capital and the structures of the learning environment. The term 'environment' defines the atmosphere, condition and activities of the learning space in its entirety. Lazio, Wilson and Simons (2004:2-29) identified workload, teaching quality, course content, supportive teaching, learning approaches and syllabus, as some aspects of the 'narrowed down' interpretation of the overarching 'learning environment' motif.

Entwistle (1991) was one of the early proponents of the perceptions of the learning environment perspective. He argues that it is interaction with the meanings attached to what goes on in the learning environment that determines learning outcomes and not the learning environment itself (Entwistle, 1991:202). Conceptions and perceptions according to Entwistle, 1991:202) have a mediating effect between the teaching and learning contexts and eventually on learning outcomes. The link between conceptions and perceptions and learning outcomes has been established by Haggis (1996:94) as that; the perception of the learning environment influences the learning approach<sup>28</sup> which a student adopts and that it is the learning approach which then explains learning outcomes.

A later publication by Entwistle, McCune and Housel (2002:9) identifies desired and 'powerful' learning environments that have the potential to yield positive perceptions towards learning, characterised as follows:

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<sup>28</sup> Entwistle (1991:201) defines the approach as the specific form of activities that students engage in learning, based on the students' perception of what the classroom tasks expect them to do.

i) Provision of a positive atmosphere that motivates free expression and interaction, where students are encouraged to express their opinions and encouraged to learn by doing. An environment where all the learning materials are accessible to all students and where content is presented in a variety of formats to cater for both the students who learn fast and those who are slow learners and designed to link to real life applications.

ii) Teaching methods that trigger the students' interest and that encourage connection to already acquired knowledge, clarity in terminology used and demonstrative learning strategies that students can relate to in their everyday experiences.

iii) Learning methods that encourage students' creativity, introspection of content and contribution of new ideas and new applications. This view is endorsed by Delpits (1988) who challenges the perception of teachers as the only experts in the classroom. Delpits (1988:288) argues that "to deny students their own expert knowledge is disempowering them .....and that both teacher and students are experts on what they know best". This standpoint emphasises the social constructivism of knowledge which emphasises that students are to make sense of what they are taught individually.

iv) Learning environments that encourage students to apply themselves and encourage group interactions to activate the social constructivist approach to learning where students arrive at solutions through an individual and collective classroom culture that encourages 'shared meanings'.

Entwistle, McCune and Hounsell (2002:8) itemises the key factors that influence how students come to understand and know themselves as mathematics learners and how they act and react to mathematics, as follows.

### **3.3.1 Teachers' beliefs, conceptions of teaching and reflective practice**

The significance of exploring teachers' beliefs, conceptions and perceptions and reflective practices is to uncover how these interfere with classroom practice and eventually how students conceive and perceive mathematics. It follows Konings et al's (2005:649) argument

that in teaching, the teacher's own conceptions and experiences on mathematics are portrayed. The beliefs/conceptions link has been adequately captured by Hudson et al. in quoting Pepin (1999:127) that one's conceptions of mathematics goes along with one's conception of how it should be presented and one's presenting style is an expression of one's beliefs about what is essential in it. For instance, conceptions that are associated with mathematics are often seen as difficult and threatening and those that portray mathematics as do-able are expressed verbally or through the teacher's actions. For instance; A teacher who has confidence in his/her students' capabilities motivates the students to work harder and this leads to the students' positive perception of mathematics. Conversely, a teacher who lacks confidence in their students acts in ways that confirm his/her beliefs and conceptions and this also affects the way students view the subject.

Jita and Vandeyar (2006:40) argue that teaching is based on the teachers' prior experiences with mathematics. This includes their experiences as mathematics students at school and at college. The authors argue that RSA mathematics teachers' experiences and mathematics identities are in the traditional approach to mathematics. That is, although teachers have different views about the nature of mathematics, the aims of teaching mathematics and the ways it could be learnt, "their teaching places more emphasis on content, memorisation, reproduction of knowledge, emulation of problem solving methods and less emphasis on reasoning and problem solving" (Jita and Vandeyar, 2006:40). The authors emphasise that there is a need for teachers to be given an opportunity to learn reformed ideas that are different from their ideas of what entails mathematics teaching practice, if the mathematics curriculum changes in RSA are to be successful. This view is supported by Hudson, Burhenan, Kansenen and Seel (1999:117) in quoting Hansen and Wenestam who argue that classroom practice as carried out by the teacher and what counts as mathematical knowledge, and how students arrive at that knowledge, is nested in the nature of the teacher's education.

In taking the argument further, Konings et al (2005:649) argue that the teachers' own perceptions and conceptions of the subjects they teach, including mathematics, are manifested through teachers' actions and classroom practices. Morrell (2001:292) identifies corporal punishment as one negative classroom practice that is rife in most schools including the mathematics classroom as the study focus. The author argues that "corporal punishment is part of a wider web of violence that fuels antagonisms and hatred". It is a form of coercion that is characterised by students' resistance and hatred of the subject they are being punished

for. This has been endorsed by Morrell (2001 in citing Cherian 1990) who established a link between students' poor academic performance, low self esteem, anxiety and anti-social behaviours, and corporal punishment.

Naong (2007:284) argues that RSA teachers claim that they had not experienced any harmful effects when corporal punishment was administered to them as students and that they see no reason why they should not administer it to their learners as well. Since the enforcement of the RSA Schools Act (1996) abolished the administration of corporal punishment to students and established that the contravention of the rule amounted to an assault offence, Naong (2007: 284) quotes teachers as decrying their loss of respect by students. The author states that teachers claim that the abolishment of corporal punishment has taken away from them their power to discipline students. This confirms Hudson (1999:129) in quoting Pepin that the teacher has traditionally been responsible not only for the academic but also for the moral development of the child.

The findings of a study by Legotlo, Maaga and Sebegu (2002:116) states that poor performance on any subject, particularly in RSA schools is, in part, due to ill discipline among students especially after the abolition of corporal punishment. They are quoted as follows: "Most students abuse the so-called 'rights' and the teachers are unable to curb this situation, more especially after the abolition of corporal punishment" (Legotlo et al 2002:116)

Ability grouping is also another classroom practice for most mathematics classrooms that reflects the teachers' beliefs as well as conceptions and perceptions of their students' mathematics capabilities. The popular type of ability grouping in mathematics classrooms is where students are streamed according to their ability range (Reuman 1989:5). Proponents of the ability grouping approach argue that it caters for the students' individual academic needs as students are grouped according to their high, average or low performance standard. Critics on the other hand argue that this practice deprives low achieving students of exposure to role models and that it becomes a self-fulfilling prophecy that emphasises their weaknesses rather than their strengths so that students are not challenged to work harder (Zevenbergen, 2005:608). Essentially, this suggests that where the experiences are positive, the greater the likelihood for students to identify with the subject and the opposite is true for negative experiences. The relevance of the ability grouping discussion for the study is to illustrate how

the teacher's conceptions and perceptions of mathematical knowledge and how that knowledge is arrived, at informs classroom practice. This is as endorsed by Zevenbergen (2005:608): that the students' ability is the interpretation made by teachers.

### **3.3.2 Teacher-student relationship**

Hudson et al. (1999 in quoting Kansanen and Marie 1999:112) notes that "even when the students are adults the pedagogical relation between the teacher and the student is mainly asymmetrical". The authors argue that this is based on the fact that the teachers possess some knowledge that the students do not have, although he acknowledges that that in some cases the relationship is democratic. A desired teacher-student relationship therefore is one that does not emphasise the power relations between the two parties as characterised by teachers' authority over the students. Entwistle et al (2002:8) argue that a positive teacher-student relationship is one that is characterised by support and academic motivation. Guidance and support for learning affects the quality of their relationship in the sense that students are assured that the teacher is there for them and affords equal treatment regardless of their varying learning paces and needs. Midgley, Feldlaufer and Eccles (1988:4) note that students' perceptions of the teacher-student relationship during their transition to secondary school or junior high is characteristically negative and this has been associated with influencing students' value of mathematics.

Midgley et al (1988:5) affirms that the perceived usefulness of mathematics and students' performance in mathematics is not dependent on the nature of teacher-student relationship for high achieving students as they derive their motivation from academic achievement regardless of the nature of their relationship. The author notes that low achieving students are particular about the nature of their relationship with teachers because it provides the motivation that their performance does not provide. Barile and Donohue (2012:8) argue that learning environments that students perceive as characterised by a positive teacher -student relationship "fosters students' sense of belongingness in school and promotes a warm school climate, which in turn may facilitate students' academic success."

Kansanen (cited in Hudson et al., 1999:112) maintains that, significant as the teacher is to the student's process of teaching and learning, students have to, at some point, be independent in

their learning and outgrow the teacher's support. The author refers to this stage as the 'pedagogical suicide of the teacher'.

### **3.3.3 Course context**

Course content refers to the way the course is designed and organised. This includes workload, the outcomes that the course intends to achieve and curriculum (Entwistle, et al 2002:8). A desired course context has been identified by Entwistle et al (2002:9) as one that triggers the students' interest and one that is grounded on sufficient time allocated for students' thorough engagement with tasks. This relates to Swindler's (2007:274) argument in Bourdieu's theory that people act in favour of their perceived chances of success in social contexts and that "one hardly pursues success in a world where the accepted skills, style and informal know-how are unfamiliar". People's perceived chances of success are expressed in their preferences, values and choices.

#### **3.3.3.1 Group Work: A Form of Social Support in Mathematical Learning**

Vithal, Adler and Keitel (2005:48) identify group work as one positive practice in mathematics learning that reinforces positive qualities to students, such as participation, learning to think, act and speak, particularly if a suitable group approach is adopted. This view is supported by Samuelsen et al (2007:157) who identified a supportive learning environment as group climate. The group work approach reinforces the social construction of knowledge in mathematics learning as advanced in the theoretical framework. Springer, Stanne, and Donova (1999:22) endorse this assertion by arguing that "many students prefer organising themselves into study groups that are active and collaborative inside and outside the classroom.

Vithal et al (2005:44) note that there is however a down side to peer study groups as there is usually one expert learner who is the one who benefits the most as he/she teaches the other members of the group while the others follow and copy the answers, in the process exacerbating the culture of learning dependence.



### **3.3.4 Students Orientations and out-of Classroom Pressures/ Social Structures**

Entwistle and Peterson (2004:413) defines learning orientations as “giving a personal context to studying that includes a consideration of the person’s aims, values and purposes for study”. While there are so many out of school classroom activities and factors that structure the way students perceive and conceive mathematics as well as influence the direction of students’ study orientations, the study focuses on in classroom and out of classroom factors that influence how students come to define their self concept and capabilities towards mathematics.

#### **3.3.4.1 Social Background and Mathematics Achievement**

Numerous studies note how mathematics achievement is prefigured by the social backgrounds that students are a product of. Mathematics learning therefore is a process of “socialising students in the norms and discourse practices of the mathematics class” and as such, social backgrounds need to be considered (Sammuelsson and Granstrom 2007:154). Stromquist (2007:7) states that socialization is a central concept used by social theorists to explain how culture is maintained in society and to account for changes in culture in society. The author notes that the process of socialization is a collision between the individual and the collective life by “moulding members into compliance and cooperation with social requirements”, noting that “the process is not predetermined, because individuals may question and reject certain cultural features”. In other words, the process is reflexive and non rigid in the process of ‘identity formation’.

The process of socialization is continuous and it occurs as the individual interacts with the social environment and it occurs in various social contexts including school and out of school. (Stromquist 2007:7) notes that “socialization in the schools, touches on the informal (hidden) curriculum is a critical dimension of schooling through which educational settings may introduce changes in social perceptions or, conversely, continue to reproduce traditional values and attitudes and it includes the activities already discussed above such as teacher-student relationship, teacher conceptions among others.

Sammuelsson et al (2007:154) further notes family socialization has a key role in socialising children to be competent in mathematics. The authors state that students from homes not so

interested in the child's school attendance seem to have a more negative attitude to mathematics than students from more supportive and well-educated homes.

Taking the argument further, Wilson (2011:111) states that parents are central in young people's consideration of their aspirations. The role of the family has been applauded by teachers in students' academic success and as a result family socialisation prefigures student's career paths and the courses to pursue and drop.

It is not every activity that parents do with children that is associated with their children's competence in mathematics learning, but it is specifically parental involvement and a supportive home learning environment and parents expectations and motivation for their children's educational pursuits (Mason, 2010:195). The key roles played by parents in their children's education have been identified by Henderson and Belar (1994:29) as follows: parents as teachers where they are hands on in assisting their children with their tasks or reinforcing what was taught at school and as supporters where parents provide any assistance they can . Although Morgan and Sorensen, (1999:674) note that parents do not always know best, particularly because their skills tend to be fade with the passing of time and they become unable to understand recent mathematical operations as they differ from those that they learnt when they were young or due to lack of education themselves; but support and encouragement are timeless and are not limited to content.

In using Bourdieu's language, the familial habitus has a structuring effect on what children come to understand and know themselves and their capabilities to be at school. Young people also tend to align their choice of majors and disciplines at university with what are acceptable within their families (Reay,1998:526). This therefore suggests that the choices and their educational preferences are mediated by the cultural capital embedded in their habitus as a result of interaction between agency and the familial habitus. The students' cultural capital is then displayed in their choices and preferences, as the institutional habitus and the students' agency collide during classroom interactions. Wilson (2011:111) maintains that students' personal aspirations should be taken into account in judging their path to future study pursuits as their educational aspirations keep on changing, particularly when they encounter some challenging situations and educational constraints.

### **3.3.4.2 Race, Class, Gender and Mathematics education**

Literature notes that there is a growing recognition of the interplay between race, class and gender factors in the construction of student identities that in schools positions some students at a disadvantage than others (Sammuelsson et al 2007:154; Grant and Sleeter 1986:185). In other words, in living life, people are wrestling with predefined class, gender, and race social worlds. One way race has been confirmed to rear its ugly head is through language in RSA students' performance in mathematics. Students tend to "achieve higher scores in mathematics when their language proficiency in English was higher and were more likely to attain low scores in mathematics when their scores on the English test were low and those that spoke English or Afrikaans at home tended to achieve higher scores in mathematics" (Howie 3002:13). This is much to the detriment of those who speak African languages as the official media of instruction is English or Afrikaans. Weis (1988:79) also notes that the teacher may even forget the students names because she/he cannot pronounce them and as such those students' presence is not appreciated to the extent that the child may even be forgotten when they are selected for certain activities.

The segregation of students into black and white is a common feature in most schools with white associated with achievement and black with failure. Tyson (2011:8) notes that the practice of ability grouping in schools (as noted earlier) or placements of students according to 'gifted' or 'talented' contributes to the process that sets racial groups on different academic paths. It sends the message to students that ability, race, status prefigure achievement. These placements influence how students come to understand their educational capabilities and their sense of place in the social environment as well as how resources are allocated in the education system. Tyson (2011:8) argues that placing the locus of social ills on individuals rather than social and economic conditions is an ill-informed way of addressing those social ills.

Reay (1991:180) states that the gender related disparities between male and female students stem from socio-cultural rather than biological factors with social class at the centre of the gender related activities. The author notes that these include issues of self esteem, confidence issues and perceptions of usefulness of mathematics particularly in male dominated or 'masculine' fields of study like maths and science. The author further notes that social class issues tend to cut across gender and race issues where children from upper class families tend

to command the teachers' attention much to the disadvantage of those from the lower echelons of society as the classroom is one social sphere where valued cultural capital is rewarded and unvalued cultural capital punished. As noted in Bourdieu's theory, even though people might have the same aspirations, it is only those who possess the valued cultural capital that are recognised. Mathematics learning is no exception to this social practice.

### **3.4 Conceptions of Learning and Knowledge**

The conception of learning and knowledge approach views knowledge to be developmental or transformational (Haggis 1996:98). Entwistle (2004:411) analyses the knowledge transformation in learning as follows. First, "learning entails remembering factual information, which involves accumulating the separate pieces of knowledge". In agreement with Entwistle (2004), Crawford et al (1994) refer to learning qualities that involve reproducing the content that was taught, treating the course as unlinked bits of knowledge, habitually memorising facts and carrying out procedures, and making no attempts to deeply engage with the course content, as associated with the 'surface approach' to learning.

Secondly, Entwistle's (2004:411) analysis identifies the next stage in the conception of learning as "the application of information which goes beyond acquisition. Thirdly, learning is equated with understanding as people make sense of ideas based on their experiences. At this stage, information becomes transformed into personal meanings. The last stage has been identified as a change in people's views about the world as a result of learning". Entwistle (1991) views the second, third and fourth stages as associated with 'deep approaches' to learning. The author defines the deep approach to learning as engaging with the study content, being constructive with it and making personal meaning and applying it to various life contexts.

Driver et al (1994:12) argue that the traditional methods of mathematics learning are a process of alignment to the 'conventional models and ideas where students accept what they are presented with in textbooks, teacher talk and guided experimental work'. The authors view the approach as a stumbling block to the students' ability to make sense of the mathematical ideas for themselves. They argue that the teacher-centred approach encourages students to believe that their role is to receive information from the teacher and remember every demonstrated step. This according to Driver et al (1994:12) results in the perception of school mathematics and the real world as separate entities.

The student-centred approach on the other hand has been found to give students more agency and positions them to be actively engaged in their learning. This parallels the social constructivism discussed in the second chapter. Boaler (2003:9 in quoting Pickering 1995) argues that as students apply themselves in mathematics learning, there is an interchange of human agency and the agency of the discipline which he terms the ‘dance of the agency’. This is where students make new discoveries of alternative ways to solve mathematical operations. Haggis (2003:99) on the other hand advocates for a change of mind in viewing this approach as ‘spoon feeding’ and reinforcing dependence, to viewing it as ‘signposting’ which for him is much needed by the students towards achievement of academic goals without compromising the overall goals of higher education and the individual needs of the students.

It is noted therefore that the conceptions of the learning environment and the conceptions of learning and knowledge approaches heralded and also underpin the conceptions and perceptions of specific subject matters such as the perceptions and conceptions of mathematics as we know it.

### **3.4.1 History of Mathematics Learning in the Republic of South Africa**

This discussion highlights the structuring effect of the apartheid and post-apartheid era on the Republic of South Africa’s mathematics outcomes in general and on the poor mathematics performance by the post-graduate social science students under investigation. The significance of this discussion stems from the fact that the apartheid era passed the baton to the post-apartheid era which structured the systematic operation of the South African education system as we know it. It therefore remains imperative to follow the sequence of events from the apartheid era to democracy. This is no attempt to be thorough or chronologically linear. It is a highlight and identification of useful and critical threads that explain in part, how South African politics has had a structuring effect on the mathematics outcomes as experienced today. This is an endorsement of Ritzer’s (2008:405) assertion that “habitus is both a product and producer of history in accordance with the schemes set in motion by history”. Understanding the history of the education system then sheds some light on how it was constructed and how we can make sense of it based on the historical understanding.

The fact that the apartheid era crafted an education system that is divided upon racial lines<sup>30</sup>, gender and the uneven distribution of educational benefits cannot be overemphasised. However, society's differentiation based on race is the most undeniable in all of the apartheid legacy, with white students being the most privileged over other racial groups as expressed in the access to the best education and educational resources (Fiske and Lad, 2004:4). The curriculum reforms in the apartheid era were thus structured to reflect the priorities and vision of the government of the time. The priorities of the apartheid government can be deconstructed from the verbalisation of Dr Hendrik Verwoerd, South Africa's Minister for Native Affairs (and Prime Minister from 1958 to 1966), in his public address on his government's education policies in the 1950s :

*"When I have the control over native education I will reform it so that the natives will be taught from childhood to realize that equality with Europeans is not for them.....People who believe in equality are not desirable teachers for natives.....What is the use of teaching the Bantu mathematics when he cannot use it in practice? The idea is quite absurd"*<sup>31</sup>

Hermann (2012:68) notes that different perspectives arose as a reaction to the Bantu education policy. There were those who believed that the policy of Bantu education was orchestrated around maintaining a poor quality education for the black child in order to maintain their subordination. The apartheid government used education as a symbol of oppression and as an instrument to instil the values of powerlessness among the black community. The author notes that it is argued that the above commentary by Dr Hendrik Verwoerd, the then Minister of Native affairs "is often misinterpreted and separated from its qualifier that all doors are open for the black person within his own community (Hermann, 2012:68) .

Regardless of the 'positive' intentions and outcomes that have been advanced by those who view Bantu education as part of reform, the study is not oblivious to the power of negative perceptions in configuring stereotypes. Mathematics learning is not immune to this effect. As

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<sup>30</sup> Considering the history of the RSA education system, the study will also allude to the racial categories where 'White' refers collectively to English and Afrikaners and 'Black' refers to African, Indian and Coloured (Fiske and Lad (2004:4)

<sup>31</sup> Extracted from Vithal et al (2005:3)

Nosek and Smyth (2009) note, “a lack of stereotypes endorsement does not imply a lack of its influence on choices and behaviour”. Policies set the vision and strategy of any developmental initiatives but people as implementers of those policies act based on the meanings they attach to those policies and this becomes a structured structure on social action as follows.

Ritzer (2008:405) argues that the political domain is a territory of power, authority and influence where political leaders are members of powerful social groups in society. They are an important reference group for much of the general populace as they have the last word on a number of issues affecting the masses including what to do and how to do it because of the power and authority of the office and the position they hold. This is confirmation of Bourdieu’s (1991:503) proposition that “it is rare in everyday life for language to function as a pure instrument of communication. Rather, utterances are not only signs to be understood and be deciphered, they are also signs of wealth, intended to be evaluated and appreciated, and signs of authority intended to be believed and obeyed”. The minister’s address therefore is intended to stress the sense of place in the social order for the black community which emphasised what they were entitled to and what they were not.

The fact that mathematics is not for all is a public narrative that has been constituted and reproduced inter-generationally as a normative standard and an unchallenged assumption about how things are supposed to be naturally (Benson, 2006:188). This explains the public’s impression that is altogether forgiving of resistance to and dislike of anything mathematical. Trigwell et al (2006:244) refer to these commonsense assumptions as situated conceptions. ‘Situated’ because it is grounded on the individual understanding and interpretation of social phenomena . That is, it is situated on the negative outlook of mathematics. Such conceptions jeopardise students’ learning outcomes.

The post-apartheid government’s challenge was to transform the education system in a direction that redressed the apartheid priorities and this has been done through curriculum reforms, policies and approaches. This continues to attest to the political field having a structuring role on how fields operate, as articulated in Bourdieu’s theory. Vithal et al (2005:6) state that in the 1980s and 1990s the social constructivism approach to learning mathematics was adopted and this brought “significant change in classroom culture and positive attitudes towards mathematics”. This is in line with the discussions on social

constructivism where students apply themselves and construct their own knowledge in learning and on how this positively influences their conceptions and perception of mathematics as discussed in the theoretical framework.

Outcome Based Education (OBE) was the second wave of education reform after Bantu Education and it explicitly articulated mathematics objectives unlike the old approaches (Vithal et al., 2005:15). Jansen (1998:2) argues that the introduction of OBE was a shift in focus from emphasising content coverage to focusing on outcomes as they made clear what students are to attend to, “directing assessment towards specified goals and shift the focus from content-heavy curriculum”. Boaler (2003:9) on the other hand notes that OBE is a student- centred approach which gives students more agency and which positions them to be actively engaged in their learning. This empowers the students to be independent learners.

The introduction of this approach was welcomed with mixed reactions as well- resourced schools implemented it while poorly resourced schools stuck to the old approaches. This therefore meant a further divide between the quality of mathematics students, as OBE suited the well resourced schools much to the detriment of the poorly resourced schools. This therefore translated to the inequalities based on class, as the medium income and higher income classes could afford to send their children to the well resourced schools. Jansen (1998:2) argues that OBE was impractical as it was a misinformed curriculum approach to education that did not take into account the realities of the South African system and was an initiative that destroyed the already fragile education system. OBE did not change the students’ perceptions and conceptions of mathematics viewed as hard, as it was presented in a “complex, confusing and at times a contradictory language” (Jansen, 1998:2). This according to Vithal, Adler and Keitel (2005) led to the third wave of curriculum reform. This has been confirmed by Daniel, Habbib and Southhall (2003:274) in arguing that the performance of the South African student continued to be disappointingly poor despite these curriculum changes.

Mathematics literacy was the next reform after OBE and it seeks to align students with the demands after they leave school. Browie and Frith (2006:30) argue that mathematics literacy was introduced so as to transfer mathematical problems to practical problems which can be analysed with mathematical tools. Graven and Venkatakrishnan (2006:9) note that the language used in mathematics literacy is not technical and thus it is accessible to the students.



Vithal et al (2005:11) admits that the division of mathematics education into mathematics and mathematics literacy is positioned as a selector and filter for future roles in society and used for determining right of access to jobs and further education. This is because the possession and lack of mathematics competency as a qualifier to higher education disciplines, channels students to pursue some career paths and not others. That is, mathematics prefigures students' sense of place in society. For instance, pure mathematics qualifies students to pursue the sciences, and mathematics literacy on the other hand qualifies students for disciplines with lower mathematics demands such as the social sciences. This translates to future roles in society in that one pursues the kind of jobs for which they have received training. With more RSA students performing poorly in mathematics, mathematical expertise has to be imported. This is confirmed by Graven et al (2006:5) who argue that some higher education institutions do not accept students even with a distinction in mathematics literacy for business studies. Graven et al (2006:5) also notes that mathematics literacy classes are flooded with students who have failed or do not cope with the pressures of mathematics.

The reforms in the curriculum have thus had very little effect in addressing the differentiated mathematics outcomes among students but rather have contributed to the inequalities. The only change between the apartheid and post-apartheid era is that “the persistence of inequality in South Africa in the post-apartheid era, is not interracial but intra-racial”<sup>32</sup>. This is as evidenced by the growing numbers of the black middle class parents affording to send their children to expensive semi-private and formerly "white" public schools that provide higher-quality education than the black dominated public schools in formerly black neighbourhoods (Nattrass and Seekings, 2001:59-64). The gatekeeper role that mathematics plays in higher education directs students to some ends and not others and this exacerbates societal inequalities based on the possession or lack of the mathematics disposition.

### **3.7 Mathematics Learning in other SADC Countries**

Considering the diversified nature of the students that attend South African universities at post-graduate level, it is imperative to paint a picture of what their mathematics experiences are so as to establish the backgrounds and experiences that inform their performance in mathematics. This would also be instrumental in analysis as, if they are found not to share

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<sup>32</sup> “Interracial refers to inequality which describes SA as a nation divided into two nations; one for poor blacks and the other for rich whites. Interracial refers to the demarcation between the employed and the unemployed and not a divide between the races” (Nattrass et al, 2001:64)

experiences or which of the experiences are similar as that would have to be accommodated in analysis.

Woolman (2006:33) argues that the mathematics curriculum for most countries in Africa reflect the curriculums of the countries that colonised them. The author notes that mathematics is a compulsory subject for the students in all sub-Saharan countries although the countries have localised syllabuses. This has been endorsed by Vavrus (2009) who argues that mathematics teaching and learning in these countries is mostly characterised by the usual chalkboard and chalk approach, teacher-centred pedagogy as the norm and teacher college trainings being grounded on social constructivism". This therefore confirms a similar approach to mathematics learning for most countries in Africa with a few distinguishing cultural contexts and languages. Ottevanger, Akker and Feitter (2007:1) write, "All the sub-Saharan countries' active learning approaches only exist in curriculum policies but are rarely practiced in the classroom.

### **3.8 Conclusion**

The body of literature investigated in this study reveals that the various ways by which students conceive or perceive mathematics has been conceptualised by other studies. The connection between these approaches, as well as how earlier approaches in mathematics learning continue to inform the students' conceptions and perceptions approach, has been deliberated. Key aspects of the learning environment that are influential on how students perceive mathematics have also been identified.

Literature confirms that the learning environment, particularly the classroom, is the key social plane where students' perceptions and conceptions of mathematics are constructed and reconstructed. It is also a social sphere where society's stereotypes about mathematics are confirmed, discarded or reinforced. The various ways in which students perceive and conceive mathematics have also been discussed and how these relate to how students perform in mathematics. They relate to the nature, character and essence of mathematics learning. The history of RSA and a brief highlight of students' performance in mathematics in other SADC countries have also been presented.

The literature has been guided by the study's research questions. It is concluded from the literature that that the willingness and opportunities to be numerate are socially constructed and closely bound up with culture, experience, interactional processes and politics among other social factors.

## **CHAPTER FOUR- RESEARCH DESIGN AND METHODS**

### **4.1 Introduction**

This chapter describes the methodology that has been applied in addressing the study's research questions. The methodology has been informed by the phenomenographic approach which was adapted as a theoretical approach that underpins the study's research method. This chapter therefore details how the phenomenographic approach as well as how the theories have informed various aspects of the research design. The chapter begins with a discussion of the phenomenographic approach and the connection between the approach and Bourdieu's theory of social practice. The discussions on the phenomenographic approach is followed by discussions of the nature of the study, details on the study group, the data collection methods, rationales for the methodologies and a description of how data has been analysed in line with the phenomenographic approach. These are discussed as follows.

### **4.2 The Philosophical Assumptions of Phenomenography: Interpretism**

Interpretism is an alternative to Positivism as the other dominant research tradition. These research traditions differ in their epistemological assumptions (the nature of knowledge), ontological assumption (the nature of reality) and methodologies (methods used to arrive at the knowledge sought). Yates, Partridge and Bruce (2012:98) state that the epistemological assumptions of the interpretive paradigm are that the individual creates, constructs and conducts meaning and that knowledge is understood in terms of the various meanings attached to social phenomena.

The ontological assumptions of the interpretive paradigm is that research approaches are based on a non-dualist ontology, where there is not an objective and subjective world as the positivist stance argues but "only one world that is simultaneously objective and subjective - a really existing world," experienced and understood differently by individuals but in an interrelated way (Yates et al., 2000).

The fundamental assumptions underlying phenomenographic research are grounded on interpretism; that a particular phenomenon cannot be understood in only one way but in a number of qualitatively different ways. Ireland, Tambya, Neofa and Harding (2009:4) argue

that the nature of reality which phenomenography seeks to uncover is that of the subjective world which assumes that social reality is constructed by individuals based on their experience and interactions with the social settings. This is the non-dual assumption that views the world and the person as in constant interaction. Phenomenographic knowledge is thus created and sustained by social processes such as social interaction. This includes interaction between the 'knower and what is known' from which individuals construct their own knowledge (Marton, 1981).

### **4.3 Phenomenography and Qualitative Research**

The phenomenographic approach is a qualitative and interpretive paradigm. The qualitative approach emphasises the multiplicity of social reality as experienced by individuals. The qualitative approach accentuates that there is not one objective truth about social reality and that there are varied meanings attached to social phenomena. It gathers in-depth data about human behaviour in order to understand the social structures that inform human behaviour. Interpretive paradigms on the other hand seek to uncover and provide understanding of the meanings behind the behaviour of social phenomena.

Yates et al (2012:97) state that the phenomenographic approach emerged in the 1970s "out of research led by Ference Marton to investigate variation in student learning outcomes". It interrogates an individual's life experiences in order to identify the array of meanings individuals attribute to social contexts. This is because life experiences are aspects of social reality that have been encountered by an individual and to which individuals attribute meanings. People attach varied meanings to various social situations.

Phenomenography is thus adopted to explore the variation in the meanings that students attach to mathematics. Emphasis is placed on the various ways that people understand or conceive of a certain social reality. This is endorsed by Larson and Horlmstrom (2007:56) in quoting Giorgi (1999) who notes that phenomenography with the suffix '-graphy' emphasises the interaction between people and social objects. The author emphasises that people interact with the meanings that they attach to social objects and not with the social objects per se - which relates to this study as it also focuses on establishing the varied meanings that post-graduate social science students attribute to mathematics.

The significance of exploring the varied meanings that students attribute to mathematics is to get a broader understanding of students' engagement with mathematics, how it is experienced by these students, and to draw inferences from the students' various experiences that point to the social contexts that influence the meanings that they attribute to mathematics. This is so as to be in a better position to understand the poor mathematics performance under investigation as a starting point in addressing this social problem. It is also through the web of individual meanings that the students' shared meanings to mathematics are mapped. This is because sociology is mainly concerned with how individual meanings are synthesised in the creation of the social. This is also in line with the theoretical frameworks as they are mainly concerned with the creation of meaning as a social practice.

The adopted phenomenographic approach to the study is more of 'social phenomenography' (Throop and Murphy, 2002:189). It places emphasis on the wider structural factors as the basis that informs individual experience. The link between phenomenography and Bourdieu's theory of social practice is that they seek to emphasise the interaction between agency and structure in understanding inequalities in society including differentiated students' performance in mathematics.

The suitability of the phenomenographic approach for the study also follows the plausible and adequate application of this approach in studies that investigate students' conceptions and or perceptions of mathematics in general and studies that "investigate the cultural patterning of subjective experience" (Throop et al., 2002:200) in particular. It does not seek to understand people's mind processes but to understand how the world appears to individuals. Below is a discussion of how this approach has been adapted by the study in informing various aspects of the research methodology. This is as discussed in the methodology subheadings that follow.

#### **4.4 Type of study**

This is a qualitative study. It seeks to provide an understanding of the perceived post-graduate social science students' lack of mathematics proficiency. It explores the varied meanings that social science post graduate students attach to mathematics. It also seeks to uncover what informs these meanings. It further explores the extent to which mathematics conceptions and perceptions influenced students' choice of research method for their post-

graduate studies. As Kraus (2005:763) states, qualitative studies facilitate the understanding of the interconnection of processes that undergird the meaning attribution process by people. The phenomenographic nature of the study emphasises the existence of multiple realities and pursues individuals for their experiences of social contexts.

#### **4.5 Research Setting**

The study took place at the University of KwaZulu-Natal Pietermaritzburg campus at the New Arts building, third floor in room 339. This venue was deliberately selected as the 'natural' environment for the research participants as this is where the Social Sciences are housed. The environment where the interviews were conducted was a quiet room with no disturbances and a space that the students are accustomed to. This was to support the process of experience recollection by the participants and to allow for free expression of the students' experiences.

#### **4.6 Sampling**

Sampling is the act of selecting a portion of the population to be investigated to participate in the study.

- i) **Non-probability Sampling:** The participants of the study were identified through purposive sampling and snowballing. Purposive sampling is where the researcher uses his/her judgment in identifying participants that would best inform the study particularly the research questions. Yates et al (2012:103) who notes that participants in a phenomenographic study should be selected based upon their "appropriateness to the purpose of the research study, that is, they have experience of the phenomenon being explored and are information rich cases". I purposively identified the first study participant and the other eleven were identified through snowballing where the selection criteria was shared with each participant who then identified the next and the next suggested the one after him/her and so on.

The sampling of post graduate social science students for the study is based on four interconnected factors namely:

- a) There is a pattern of poor mathematics performance that characterises the RSA's education system and that this pattern has also been echoed in higher education

(Zettle 2003:200) and Edling (2002:200). The social sciences are part of this education system and thus no exception to the concerns that run in the system.

- b) There are courses with mathematical applications in the social sciences. Muijis (2004:3) states that it is the mathematics language that puts a lot of students off as students find it intimidating. This statement is supported by Babbie (1998:458) who states that most students have the fear of mathematics even in higher education which he refers to as “congenital mathematics deficiency syndrome”. The author also notes that the number of students who do statistics as part of research methods who report that they are ‘simply no good at maths’ is beyond belief (Babbie 1998:458).
- c) Most students in higher education are unable to undertake quantitative work independently because the concepts in quantitative work are mostly presented in the mathematics language (Gibbs, 2010:2).
- d) The claim by Durrheim and Tredoux’s (2002: v) that the social sciences are characterised by a diversity of students from various educational backgrounds, culture and thus possess various knowhow and skills including varying mathematical skills as the discipline does not emphasise of the possession of mathematics unlike in the pure sciences in pursuing the discipline. Such a diversity renders the social sciences fertile ground to achieve the objectives of the study.

Based on these considerations therefore, the study identifies post graduate social science students to establish the applicability of these assertions to this social group as they are part of higher education, an integral part of the RSA education system and they do statistics in research methods. The study does this by establishing what their conceptions and perceptions to mathematics are, what the social conditionings that the students are a product of are, that could have influenced how they perceive and conceive mathematics and how this is played out in their mathematics performance and their research choices and preferences. This is as highlighted in the research questions.



The significance of finding answers to these questions is to identify the causal factors to the students' problems with mathematics, particularly their performance in mathematics, if confirmed or discovered as this would have repercussions on the quality of quantitative research undertaken by the students.

Social Science clusters were identified based on verification with the College office and confirmation with some students in the respective clusters that these disciplines do courses with mathematical operations and applied mathematics, in line with the objective of the research. Participants of the study are students who do or did either Research Design and Statistics (Socy703P1) and Data Analysis and Presentation (LIIS834P1) as courses with applied mathematics or mathematical operations at varying levels. The participants had also done mathematics throughout their primary and high schools and somewhere in the tertiary level. The participants' research methods for their current research were also taken into consideration so that the sample is representative of both qualitative and quantitative studies. This was done so as to establish the extent to which students' conceptions and perceptions had influenced their choice of current research method for their post-graduate research.

**ii) Sample:** The participants were from the Society and Social Change cluster, Development Cluster and International and Public Affairs<sup>33</sup> as follows:

- i) Four participants from the Development cluster e.g. Information studies
- ii) Four participants from International and Public Affairs cluster e.g. Policy and Development studies
- iii) Four participants from the Society and Social Change cluster e.g. Sociology

**Table 1: Representation of the Study Participants per Cluster**

Cluster	Development	Information Studies	Society and Social Change
No. of Participants	4	4	4

<sup>33</sup> Culture cluster was purposely left out because they are not represented on PMB campus at post-graduate level.

**iii) Sampling Rationale:** Students from the social sciences were sampled following its ‘accommodative entry requirements’ in relation to mathematics. This is in comparison with the pure sciences where mathematics is a ‘strict’ entry requirement. This renders the discipline fertile ground for the diverse students’ mathematical capabilities in line with the study objectives. Such diversity was viewed as being a much needed ingredient for the study’s objectives as the more diverse the sample, the greater the chances of soliciting the varied meanings students attach to mathematics. The social sciences were identified because they are more logistically convenient and accessible for the researcher.

Post-graduate students were identified as the research participants in order to accommodate the reflexivity aspect in the meanings students attribute to mathematics, so as to capture any possible changes in their conceptions and perceptions of mathematics throughout their educational history.

**iv) Sample demographics**

The demographic distribution of the study participants according to gender, level of study and national status (international<sup>34</sup> and South African students) was as follows. This is shown in order to accommodate the social dynamics that could potentially be at play within the KwaZulu-Natal Social Science programme in relation to its dominance by international students and whether these have had an influence on the direction of the study.

**Table2: Demographic Distribution**

Gender		Level of Study		National Status	
Female	Male	Masters	PhD	RSA	SADC
8	4	6	6	6	6

7 of the female students were at masters level and 1 of them was doing PhD. 1 of the male students was at masters level and 3 at PhD. None of the female PhD students are from RSA and 1 of the male PhD students are RSA. 4 of the masters female students

<sup>34</sup> International students refers to the students that are from countries outside of South Africa

are from RSA and 1 of the male masters students are from RSA. 1 of the PhD female students are from SADC and 2 of the male PhD students are SADC. 3 of the masters female students are from SADC and 1 of the male masters students are from SADC.

The study's demographic overview indicates an even distribution of the students between level of study and nationality status. Notably, all of the participants were black. More females participated in the study than males. Although this arrangement is not by design, effort was made to balance the representation of the participants' views between genders to avoid the findings of the study being predominantly female views by encouraging participants to suggest male participants too. The level of study distribution is a desired distribution for the study as it presents a representative sample for the Social Science cluster. The even distribution between local and SADC (Southern African Development Community) students necessitates a comparison of mathematics experiences of other SADC countries with the South African mathematics learning context. The social factors that informed their experiences could have varied with the various national backgrounds. This however had no negative bearing on the study itself as the study's focus does not exclude SADC students, as they are part of the social group under investigation. The study has also accommodated SADC countries in the literature.

A total of 12 students participated in the study comprised of 4 males and 8 females, 6 from the Masters and 6 from the PhD level in the Social Sciences. The participants were registered post-graduate students for the 2014 academic year. The use of a limited number of participants is a specification of the phenomenographic approach that emphasises a limited number of participants due to its potential to produce dense amounts of data to be analysed that might not be manageable.

Six (6) of the participants were RSA nationals and 6 were from different SADC countries. The balance between the RSA and SADC students in the sample allows for comparison of the mathematics experiences of the students from other countries other than RSA that are enrolled in the post graduate social sciences.

#### **4.7 Data Collection Method**

Data collection is the act of obtaining information that is useful in addressing the research questions. One-on-one (individual face-to-face) interviews were used to collect data. Face-to-face interviews are the primary method for data collection in a phenomenographic study, as Yates et al (2012:102) note. The interviews were a dialogue between the researcher and participant to encourage free expression of recollections and to support the process of reflection by the students. This is also because face-to-face interaction enables deduction of meaning from the interviewee's utterances during interaction. The use of open ended questions for the study was also to "allow for exploration of lines of reasoning that may have not been anticipated yet insightful for the study" (Yates Patridge and Bruce, 2012:102).

While data may be gathered at an individual level, phenomenography focuses on collective awareness and variation in how individuals experience a phenomenon so that the individual information is the basis to build on in establishing shared meanings among members of society (Yates et al 2012:202).

#### **4.8 Data Collection Instrument**

The interviews were based on semi-structured questions as attached in the appendix. This allowed for detailed and unlimited expression of the students' experiences and for deeper insight into their experiences with mathematics. Yates et al (2012:202) states that the use of semi-structured questions is recommended for phenomenographic studies as it allows for an in-depth exploration of individual social experiences without leading the participants.

Interview questions were designed to provide data that would help establish critical variations in the ways of understanding mathematics by students, in mathematics teaching and learning and in the ways students view themselves as mathematics learners drawing on their entire education experience with mathematics. Mitchell (1994:8 as quoted in Haggis 1996:94) challenges the use of conceptions and conceptions as survey instruments, arguing that "they are not actually measuring conceptions but only what students say in response to questionnaire items or they are merely learners' impressions". This is however not apt, as knowledge is preceded by the world of experience and knowledge of the lived world is expressed in speech or words. Survey instruments thus provide guidance as to which pool of

knowledge the interviewer has to tap into, to access individual meanings as expressed in words.

Social constructivism and Bourdieu's theory of social practice influenced the way the research questions are framed. This has filtered into some of the research questions as illustrated below.

- i) How meanings that people attach to social contexts vary between people and across cultures and thus students attach different meanings to mathematics: by the interrogation of the heterogeneity and variance in meanings attributed to mathematics.
- ii) How meanings interfere with the experience of learning which then impacts mathematics outcomes: by soliciting how students' perceptions and conceptions influenced and continue to influence their view of the mathematics learning environments, teaching approaches, their choice of research methods and primarily how they performed in mathematics.
- iii) How society's social practices and social contexts provide a pool of options from which meanings are constructed: by establishing activities that students engaged in at school and out of school that had mathematical connotations and how these have informed the way they conceive or perceive mathematics. This includes, but is not limited to, approaches to studying, familial involvement and disengagement in helping the students acquire the mathematical disposition, mathematical associations in play and other out of school activities, and students' perceptions of the learning environment among others.
- iv) How meanings are an integral part of our habitus and how they become the lens through which we view the world: by establishing students' perceptions and conceptions of their own mathematical capabilities, interrogating how their perceptions and conceptions of mathematics influenced their mathematics outcomes, finding out whether their conceptions and perceptions had anything to do with their choice of the social sciences.

#### **4.8.1 Data Collection Process**

Data collection was carried out from 10<sup>th</sup> to 18<sup>th</sup> June 2014. Each interview took between 20 and 25 minutes on average. Although it was anticipated that the students would take much

more time than this, the students had ready answers for the questions as if their experiences had all happened yesterday. They did not struggle to recall their experiences from childhood to the present. The study was thus able to solicit in-depth information on the investigated subject in a short while. The interviews were audio-recorded and notes taken so as to correlate observations with the discussions in analysis.

All the interviews were in English, as anticipated, except for one participant who preferred Zulu. This was however not a challenge as the interviewer is also Zulu speaking. The questions were then translated into Zulu for this one participant. It was observed that the Zulu interview took longer than the English interviews (approximately 45 minutes) as the participant took his time to explain. This can be attributed to the observed fact that there is a lot of repetition, detail and emphasis in the Zulu dialect compared to English, the use of which was found to be an advantage rather than a disadvantage for the study.

#### **4.9 Interpretation and analysis of data**

This process was guided by the phenomenographic approach as advanced by Larson and Holmstrom (2007:55). It was applied as follows. Since the data from the interviews was audio-recorded, the first step in interpretation was to listen to all of the recordings. I listened to the recordings for the second time and wrote out or transcribed the data from the tape recordings one recording at a time per question. As I listened to the recordings, I marked out units of meaning, grouping the units of meaning to form themes. The themes that emerged from the recordings were aligned to the research questions and research objectives. General and unique themes were highlighted and ordered in a way that made it easy to follow during write up and “organised to demonstrate a logical relevance of an expanding awareness” (Ireland, Tambya, Neofa and Harding, 2009:11). This process was done individually for each student to capture the varied meanings students attached to mathematics. Since the phenomenographic approach searches for variation in student understanding about phenomena based on their experiences with the subject, the transcriptions from the individual interviews produced an array of meanings to be analysed which identified and described the various ways the students conceptualised mathematics and their experience with the subject. Themes were also identified based on the repetitiveness of some words or phrases used by the

students. The data was then categorised according to similarities and differences, and categories of descriptions were formulated<sup>35</sup>.

The study sought to go beyond the limit of analysing only the ‘qualitatively different ways of understanding’, to paying attention to some details like the how and the why of the ways a phenomenon is understood in order to comprehend the poor mathematics performance phenomenon “more deeply and in a more rounded way”<sup>36</sup> to “defamiliarize the familiar” (Macionis and Plummer, 2007:5). Reid, Wood, Smith and Petocs (2005:571 and 572) admit that, in their phenomenographic analysis, “they have extended the phenomenographic approach in several ways, taking the analysis beyond the standard phenomenographic approach”. Capturing the structures and relationships in the phenomenographic approach thus brings clear understanding of the phenomenon.

#### **4.10 Ethical Considerations**

It is a key research principle that when humans are used for a research project, the utmost care is observed so that the rights of those individuals are not violated. The ethical considerations undertaken were as follows:

##### **a) Consent for conducting the research**

Consent to conduct the research was obtained from

- The Humanities and Social Science Research Ethics Committee (approval letter attached as appendix)
- The Registrar (attached as appendix)
- The post-graduate social science students as the research participants (copies of signed consent forms submitted to supervisor and stored as per university procedure).

The participants’ involvement in this research was on a completely voluntary basis and the participants were informed of the details of what the study was about and what it sought to achieve, prior to consenting to participate. They were asked to consent by signing a declaration form as evidence of agreeing with the set terms and conditions explained on the consent form that they were asked to read prior to the start of the interview.

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<sup>35</sup> Summary of phenomenographic approach outlined by Larsson et al (2007:57).

<sup>36</sup> Sourced from Macionis et al (2007:45)

**b) Freedom from harm:** There was no physical harm anticipated from the study. There was however a degree of psychological discomfort that could have resulted from the questions asked, as it was anticipated that some students might not be willing to share their experiences, particularly negative experiences. This was however not a problem with any of the participants. The participants were informed of their option to discontinue the interview if such discomfort was triggered by the questions.

**c) Principle of respect for human dignity:** Participants who were not prepared to share their experience were not forced to participate. It was indicated that the participants were free to end the discussions should they feel uncomfortable during the course of the discussions. Participants reserved the right to ask for clarification on aspects of the research for which they needed clarification. The objectives of the study were explained to the participants prior to the start of the interview.

**d) Anonymity and confidentiality:** These are mainly concerned with an individual's right to privacy. Confidentiality and anonymity were observed by conducting the interviews individually and in a private space. Anonymity was also adhered to by not requiring the study participants' names or any distinguishing and identifying information, so as to preserve the participants' identity. Numbers were assigned to each participant as a substitute for their names and these numbers were also used in the analysis. Confidentiality was maintained for the two students that were known to myself as the researcher.

The study's hard data and electronic data were kept safely by the researcher during the analysis process and were handed over to the supervisor to keep as per university procedure, after the analysis.

#### **4.11 Limitations of the Study**

The study limits its focus to students' perceptions and conceptions of mathematics as one aspect of mathematics teaching and learning. Although it is essential to hear students' perspectives on mathematics, this is however a one-sided view to the teacher-student interaction as it focuses solely on the students. This therefore suggests that the study needs



complementation by other studies that focus on both the teacher and student perceptions and conceptions of mathematics, thus identifying the middle ground.

The study's findings cannot be empirically generalised due to the limited sample size and the specific nature of conceptions and perceptions, but is suggestive of how students' poor mathematics outcomes can be interpreted and understood from a sociological viewpoint. It is also observed that the views of the study are entirely from black student participants. Although it would have been informative to have more than one race participate, the dominance of black students in the study is a true reflection of the social science post-graduate programme. The small sample size also comes across as the study is self-selective of 'maths haters'. A much bigger sample is thus suggested for future studies of this nature.

The study only investigates how conceptions and perceptions influence performance in mathematics (one directional relationship) and does not pursue further the reverse relationship where mathematics influences conceptions and perceptions. However this relationship has been confirmed to exist by the study.

#### **4.12 Conclusion**

The chapter outlined the research design that was followed by the study in achieving the research objectives. It used the phenomenographic approach as the underpinning theoretical framework which is adopted for most investigations on students' conceptions and perceptions of mathematics. It discussed the nature of the study, research settings, research methods, the data collection process, ethical considerations among others. The chapter highlighted that it extended beyond focusing on only the variations in meanings attributed to mathematics in capturing the social factors that informed the meanings students attributed to mathematics. Ethical considerations that the study observed were outlined as well the process that the study followed in the analysis of the findings.

## **CHAPTER FIVE: RESEARCH FINDINGS AND DISCUSSIONS**

### **5.1 Introduction**

This chapter is a presentation of the research findings following face-to-face interviews with post-graduate social science students of the University of KwaZulu-Natal. It builds on the premise that students enter university with a range of qualitatively different conceptions and perceptions of mathematics and approaches to learning it (Crawford et al., 1998:456); and that these conceptions and perceptions influence how they perform in mathematics and courses with mathematics as an underlying method. The understanding of the interrelationship between students' conceptions and perceptions as precursors of learning behaviour is applied to shed some light on "inability of students to undertake quantitative work independently due to the presentation of concepts in quantitative work in the mathematics language" (Gibbs, 2010:2) as highlighted in the research problem, with a particular focus on post graduate social science students.

Regardless of the enormity and the multifaceted nature of the poor performance in mathematics, this analysis is limited to an interpretation of the responses that have been brought up by the students during the interviews. The students' mathematics experiences represented their lived and contextual reality with the subject. This facilitates our understanding of how the meanings that the students attach to mathematics shape the students' mathematics performance. The "personal meaning for the student may well be tied up with many aspects of life that are not closely connected to the study" (Haggis, 2003:94) and this helps us understand the social structures and social relationships that inform these meanings. Meanings tell a story about the social processes, cultures and nature of societies that those meanings are a product of. The research questions are framed to capture these classroom and out of school experiences. The focus on students' experiences with mathematics is in line with the study's key objective which is to understand the causes of poor mathematics performance among students, particularly this social group, if found to have the problem. The study's findings are also positioned in line with the study's theoretical frameworks and with the literature.

The findings seek to address the following research questions as highlighted in Chapter One:

- What are post-graduate social science students' conceptions and perceptions of mathematics?
- Why do post- graduate social science students interpret mathematics the way that they do?
- To what extent do post- graduate social science students' conceptions and perceptions of mathematics influence their choice of research method for their post graduate studies?
- What is social science students' perceived usefulness of mathematics in post-graduate social science studies?
- What is the relationship between post-graduate social science students' conceptions and perceptions and mathematics outcomes?

In presenting the findings and the discussions, the chapter is divided into themes and subthemes that emerged during the transcriptions of the interview and these are structured to address the research questions as discussed in the methodology section. Themes emerged through the use of a phenomenographic approach and the findings were interpreted in line with the findings of previous studies as presented in the literature as well as in the theoretical framework. The presentation of the findings and the discussions is not in the order that the questions were asked in the questionnaire, for two reasons. Firstly, the questionnaire was structured in a way that sought to avoid leading the students to respond in a particular way. This is particularly because the study made use of sociology students, who at Masters and PhD level could easily have pre-empted the direction of the study and played along, much to the detriment of the study. Secondly, in identifying the themes and sub-themes, the submissions were reorganised during the analysis from the order in which they were asked in order to develop a clear understanding and to 'demonstrate a logical relevance'<sup>37</sup> of an expanding storyline.

All the questions asked are tactically incorporated in this section, capturing the key constructs as identified by the theory and as endorsed or refuted by the literature. Each of the questions was asked to all of the students, however, in presenting the findings, quotes that represented both the majority and minority students and those that best articulated their points of consensus and disagreement were included for analysis. Attention was paid not to self-select

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<sup>37</sup> In borrowing Ireland et al's (2009:11) words.

responses that suit the aspirations of the researcher and this could be verified as all the recordings and transcriptions were sent to the study supervisor as per university procedure and for transparency.

In the introduction, the study makes a distinction between conceptions and perceptions and states that this distinction is merely an acknowledgement of the differing processes that give rise to these concepts and does not imply that the study distinguishes these in analysis. Essentially, “the concepts are not easily distinguishable and they cannot be reduced to the immediate observable aspects of behaviour” (Ponte, 1994:2). In the analysis therefore, the study does not make any attempt to distinguish between these concepts as the use of both concepts is just an effort not to mask the inherent distinctions that characterise these concepts, which are however undistinguishable. For that reason therefore, the study carries over to this section, the application of both concepts.

## **5.2 What Mathematics Means to UKZN Masters and PhD Social Science Students**

“Any answers to questions that seek to solicit people’s understanding, meanings and interpretations of social phenomena are statements about people’s conception of reality” (Marton, 1981:178). Based on that premise and to establish the students’ conceptions and perceptions of mathematics, the students were asked what their understanding of mathematics was? The following responses are a collection of the defining factors that the students identified. These are;

*Student 1: “Numbers, logic, mystery”*

*Student 3: “Maths is calculations, formulas and equations”*

*Student 4: “Maths is numbers, equations and quantification”*

*Student 5: “Maths is numbers, addition and subtraction”*

The responses illustrate that the compositional domain of mathematics as numbers, formulas and calculations was the most popular among students. This was regardless of the students’ national background. It underlines Douglas’s (1996:12) assertion in the literature that one of the ways that students conceive mathematics knowledge is according to its nature. Number, calculations and formulas are aspects of the nature of mathematics. Houston (2010:71) explains that perception or conception of mathematics according to its nature is a narrow interpretation and that students who perceive mathematics as solely numbers and calculations

are likely to use a surface approach to learning. Entwistle, (2004) associates the surface approach to learning with poor mathematics performance as students fail to go beyond the knowledge acquisition stage to application, understanding and knowledge production.

Student 1's perception or conception of mathematics as numbers, calculations and then logic was profound. This is because it was a collection of all the ways that mathematics can be conceptualised. The student demonstrated the evolutionary and progressive nature of mathematical knowledge. The student's wide ranging understanding of mathematics from nature to character emphasised the student's broad experience with the subject because individuals can better recount social contexts they have had an encounter with.

One of the students also defined mathematics as follows;

***Student 10:** "Oh, my favourite subject in high school. Mathematics is about solving but not only about solving, you can actually apply it to real life, you know...calculating how old my mum was when I was born, calculating how much something costs, calculating distances- if it's worth it going this way and not this way".*

The interpretation of mathematics as the solving of real life problems has been identified as a 'life' conception by Reid et al (2003). As noted in the literature, mathematics is viewed as an approach to life and a way of thinking and the learners make strong personal connections between mathematics and their own lives. This is confirmed by this student's self-perception as 'good in mathematics and as a numbers person' even before attempting to answer what her understanding of mathematics was. The 'life' conception has been conceived as a cohesive perception of mathematics. A cohesive perception means that students view mathematics as linked applications that are a progressive body of knowledge that allows for creativity. Houston (2010:71) argues that students with a cohesive conception are more likely to use a deep approach to learning which he also associates with proficiency in mathematics. Student 10's response suggested her understanding of mathematics not just based on its nature and character but also as having a personal utility value.

I get a sense of a collision between this student's habitus and the structures of the mathematics field from this submission, where the student engaged with mathematics to the position of acquiring personal meaning and the discovery of alternative methods of solving

mathematical operations from the conventional. This fits earlier views as expressed by Pickering (as cited by Boaler 2003) that as students engage in mathematical activity, there is an interchange of human agency and the agency of the discipline which the author refers to as a 'dance of the agency'. An application of Bourdieu's interpretation of how the students conceive or perceive mathematics would be that the meanings that they attach to mathematics are an expression of habitus as an embodiment of the immanent structures of the mathematics field which structure how they perceive or conceive mathematics (Bourdieu 1998:81).

Essentially, two categories of perceptions or conceptions of mathematics emerged from the students responses: 'numbers' and 'life' conceptions. These have been identified by Crawford (1998:458) as representing the "major qualitative divide" within the structure of conceptions and possibilities for students' learning behaviour. These are significant links in understanding mathematics outcomes because they speak of the nature of experience and relationship the students have with mathematics. The students' responses clearly pointed largely to a history of interactions with mathematics that was limited to general arithmetic and was a narrow conception of mathematics. This then suggests a likelihood for these students having a limited comprehension of mathematics.

The meanings that the students attach to mathematics as noted above, from the limited to broad conceptions and perceptions, has been explained by Bourdieu to be an outcrop of the mathematical background that makes up the students' mathematics habitus as a result of their interaction with mathematics in various social and educational spheres. As noted in the theoretical framework, "the dispositions of habitus are acquired, in part, through the experience of social interaction" (Swartz 2002:63S) and thus the meanings that the students attach to mathematics reflect the nature of interactions that inform their mathematics experiences.

Some responses could not be classified as conceptions as they reflected the students' feelings about mathematics. Others could be classified as conceptions but still the feelings aspect kept on recurring. Bourdieu (1990:70) states that feelings are an expression of the embodied structures of the world or habitus. These are some of the responses in which feelings were expressed. Notably, the inclusion of only these three submissions does not suggest that two students expressed hate feelings and one expressed love feelings. However these three are a

representation of the love/hate feelings that were expressed by the students not in terms of ratio.

*Student 11: "Maths for me is boring, it is discouragement and in fact every thought I have about mathematics is negative"*

*Student 10: "Mathematics is my favourite subject. It applies to problem solving even in real life"*

*Student 2: "I hate math"*

Of note in these responses is how mathematics was interpreted in relation to self. It is interesting to note that all the students voiced their feelings towards mathematics at some point in the interview without any specific probe whatsoever in that regard. It seemed to be a reflex response rather than a conscious choice of words. It confirms people's inclination to interaction with self in the process of meaning attribution. That is, the discussion probably provoked an internal conversation. This is the act of reflecting rationally or the process of critical introspection that Swartz (2002:63S) refers to in Bourdieu's theory that is triggered by the process of meaning attribution. As discussed in the second chapter, through students' introspection, they attribute meaning to their mathematical capabilities and this influences their perception and conception of the subject.

The students' expression of feelings towards mathematics confirms Trowler's (2005:24) assertion that "meanings evoke responses of hate, delight, fear, anxiety, worry, stress" and that feelings depend on the meanings or interpretation of the symbol. The feelings that emerge are love and hate feelings towards mathematics and are triggered by the students' individual experiences with the subject. They are a manifestation of how habitus orientates not only action but also reaction. The students' hate feeling seems to suggest the opposite of the characteristic features that identify a competitive player in a field as Mois, (1991:1022) asserts. The author states that, "like competitive athletes, players must have a sense of what is at stake, an investment in the outcome and above all a feel for the game" and the hate feelings do not illustrate a 'feel for the game' - thus incompetence in the subject is inevitable. The love feeling on the other hand illustrates a 'feel for the game and thus competence in the field is foreseeable.

### 5.2.1 The Social Meanings of Mathematics

As discussed in Chapter Two, social meanings are the interpretations of social contexts that people share as a collective. They are the shared social structures through which society's interconnectedness is sustained. These have been deconstructed from the following responses and these responses have been selected on the basis that they best express the general feeling of the respondents:

**Student 1:** *"It became apparent in high school that you are not educated unless you have mathematics and so I did it as a prestige thing... It's a prestige thing in that you can claim you are an intellectual and prove you can think clearly"*

**Student 3:** *"Mathematics comes with a status, it is glorified, and if you know maths - you belong to a special breed... There is no pride outside of the sciences"*

**Student 9:** *"The ones who passed maths became the most respectable in the group"*

There was general consensus among the students that mathematics was receiving a central place in the dominant culture. This was expressed in the use of words like respectable, glorified, special and prestige. They seemed to support the view that it is a social symbol of intelligence and success which is attached to its "universal status and a key area of knowledge" (Anthony and Walshaw, 2009:6). However, although the students generally agree that mathematics is receiving a central place in the dominant culture, there are those (although a minority) that question this status quo. Interestingly, some of them are the very students who acknowledge that mathematics receives a dominant place in the dominant culture. This suggests that acknowledging its place in the dominant culture does not imply that they do not question this arrangement. This was expressed in different quotes as follows:

**Student 1:** *"I am not avoiding maths, but am not thrilled to be doing it either"*

**Student 2:** *"I could not see how half the things taught in class relate to real life".*

**Student 3:** *"To this day I cannot tell you what the relevance of mathematics is to my studies".*

**Student 6:** *"When I saw the statistics module, I knew this is not what I had signed for"*

There was also those who were supportive of the idea of mathematics central position in the dominant culture although they were few. They are quoted as follows:



**Student 4:** “Mathematics particularly applied mathematics is key in the social sciences as so many problems could be solved by applying it”.

**Student 8:** “Maths background makes one better equipped for other life experiences”.

In applying Bourdieu’s theory to interpret the students’ submissions, it can be said that mathematics is recognised by agents as a powerful capital and it has become the icon for society’s unchallenged status quo and “it struggles to relegate challengers to a position of heterodoxy or as lacking in capital” (Moi, 1991:1022). The position that dominant culture’s challengers are relegated to is that of subordinate culture. Those who possess the mathematics disposition as symbolic capital therefore wield power. This suggests that, if mathematics receives a central place in the dominant culture, disciplines with minimal mathematics requirements are relegated to the status of a subordinate culture. This therefore implies that students who are proficient in mathematics belong to the ultimate mathematics culture and students who lack the mathematics disposition belong to cultures subordinate to mathematics.

This is confirmation of the literature where mathematics is identified to play an exclusivist function in society by dividing society based on the possession or lack of the mathematical disposition as a qualifier in the education system. This according to Bourdieu illustrates the distribution of cultural capital in society and which cultural capital is valued by society and particularly the education system. The classroom is thus the social and structural plane or a system that rewards some cultural capital and not others. A habitus aligned to the mathematics way of doing things or institutional requirements is rewarded and a habitus that is misaligned to the valued habitus in mathematics learning is punished and not rewarded. Bourdieu argues that what mathematics requires as a field, society does not prepare the students for. This means that most students’ history of interactions does not qualify them for competence in the mathematics field.

Two of the students’ submissions seemed to express a sense of demotion or self-condemnation after having been rejected an opportunity to pursue mathematics. These were included as voluntary submissions and not part of any question but notable. This is deduced from the use of words like ‘rejected’, ‘eliminated’, ‘look for another’ among others. The sense of demotion and condemnation has been verbalised as follows:

*Student 1: "I was rejected in pure science because my maths was not strong - these were childhood ambitions".*

*Student 2: "I was not good in maths therefore eliminated my wishes to do science".*

*Student 4: "I actually did science but got sick and therefore had to look for another field that is not physically challenging".*

These responses illustrate the students' willingness to identify with mathematics as it enjoys the central positions it receives from the ultimate culture. This means that the way these students had come to understand themselves was shaped by the social constructions of mathematics as a culture to reckon with in society and failure to live up to those societal expectations invited a negative sense of self as expressed in the use of words like 'rejected' and 'eliminated wishes'. Parents have been found to play a crucial role on the construction of the social meanings through which children come to understand themselves and their capabilities in mathematics. As Wilson (2011:111) asserts, family socialisation prefigures student's career paths and the courses to pursue and to drop.

### **5.3 Mapping Social Factors that Inform Students' Perceptions and Conceptions of Mathematics**

This section identifies the social structures that play a part in informing students' learning behaviours. It is based on the understanding that people's realities should not be viewed as existing outside of what is happening in the social. It looks at the immanent structures of the social world for insight on why students view mathematics the way that they do. In other words, what are the dispositions and the social relations that make up students' habitus and how these affect how students are treated in schools and therefore how they achieve.

The students identified the 'in-school' learning environment and the 'out-of-the-classroom' environment as the two main social spheres or fields that inform the way they perceive mathematics. These have been found to reinforce one another in doing so as they are in constant interaction. These are some of the factors that the students identified. They are presented in keeping with Entwistle et al (2002:8) assertions as highlighted in the literature.

### 5.3.1 Teaching methods:

*Student 1: “Mathematics was taught using examples, exercises, and illustrations on the blackboard. The teacher would then go around checking if we are following”*

*Student 6: “At primary, the teachers were supportive, assisted where we struggled. It was pleasant because the teachers were passionate - checked homework’s, allowed us to approach them for assistance but things felt different when I was alone”*

*Student 8: “At high school it was assumed the basic things you knew. At primary we were introduced to everything. The patience, the willingness to get us aboard is different between primary and high school. The teacher just moves on without revising previous chapters”*

These sentiments summed up the experiences of all the students regardless of their country of origin. Teaching is the instrument adopted by the education system to prepare students for the needs of the mathematics field and teachers are the custodians of the learning process in culturing students on the mathematical way of doing things as required in the mathematics field. Mois (1991:1022) states that for a field to work, “there must be people equipped with the habitus of the field which enables them to know and recognize the immanent laws of the game”.

The students claim that the teaching strategy adopted by most mathematics teachers is through the traditional teaching method where examples would be extracted from the textbook, deliberated in class and then the students given some exercises to practice. It is assumed that the similarities in the students’ submissions suggests that the teaching method employed was similar regardless of the type of school attended, although there was no specific question on the type of school attended. The students submit that, depending on the teacher’s approach, these would be revised before moving on to the next topic while other teachers proceeded without revision. What emanates from these responses is that teaching methods that do not challenge the students to work independently are perceived as ideal by the students. This is because it allows them to shift the responsibility to the teacher as the ‘expert’ while they remain unconstructive. A shift in teaching approach to challenge the students to apply themselves is perceived as ‘unsupportive and unpleasant’ by the students. This speaks of a habitus that does not like challenge but is comfortable in its comfort zone as a strategic response to the students’ anticipated constraints as informed by their deeply ingrained past experiences with mathematics. The downside of the so called ‘supportive’

environments is that it tends to misrepresent what ought to be the main reason for studying mathematics, which is to make some new discoveries.

Driver et al (1994:12) in the literature link the use of the traditional method of teaching where students emulate problem solving models and ideas with disempowering the students' ability to construct knowledge. In other words, Driver associates this method with students' dependence on the teacher. In applying Driver et al (1994) assertion, it is no wonder that student 6 admitted that "...but things felt different when I was alone" because the traditional teaching method does not prepare students for independence and the discovery of solutions to problems through trial and error. The '*different feeling*' that student 6 admitted to having experienced is an expression of a cognitive schema that challenges habitus in its comfort zone. Teaching strategies that discourage students to construct their own knowledge are the reason students' fail to connect school mathematics to real life applications according to Driver et al. (1994:12).

Considering the main objective of emulating models and methods in the traditional teaching method as 'signposting' for the students as Haggis (2003:99) claims, it is argued that the problem is not inherently in the method. As Entwistle (1991:202) affirm, it is the students' perception of the method that is a problem not the method itself. That is, students do not perceive the traditional teaching method as 'signposting' or a guide to the kind of knowledge they have to independently research. The students perceive the method as memorising what has been taught in class, which then explains their dependence on the teacher. As a consequence, students' fail to establish the continuity between school mathematics and its real life applications (Driver et al, 1994:12). This leads to mathematics being perceived as a stagnant body of knowledge that allows for no creativity. This according to Douglas (1996) is the perception of the character of mathematical activity.

Students who participated actively in their own learning and applied themselves before and after class have admitted to having enjoyed 'AHA! moments or moments of illumination' (Liljedahl 2005:220) in their mathematics learning and these are quoted as follows:

***Student 10:*** "I would not go to bed without having worked on what we were doing in class and I assisted others with it at school so that I grasp the concepts and applications more"

**Student 6:** *“I once asked my cousin for assistance with my mathematics and I failed. From then on, I worked on it all by myself and I passed”*

These submissions confirm Bourdieu’s claim that the dispositions of “habitus are acquired through the experience of social interactions by processes of participation, imitation, repetition and role playing among others” (Swartz 2002:62). The students above therefore admitted to acquiring the mathematics disposition by actively participating in their learning as well as repeating and role playing what had been learnt in class. Notably, it was only these two students who admitted to have applied themselves in mathematics learning and that their hard work paid off as they passed mathematics.

The responses also correspond to Liljedahl’s (2005:220) as quoted in the literature that the negative public narrative about mathematics being hard, is challenged as students discover solutions to mathematical operations by aggressively engaging themselves with them. The students become ‘experts’ in their own right and this boosts their self-concept about their mathematics capabilities. The submission emphasised the continuity between school and out-of-school if more moments of illumination are to be enjoyed. The interaction between the home and school field is confirmation that society is a web of interrelated fields.

### **5.3.2 Organisation of content:**

The students’ submissions emphasised the role of the organisation of mathematics content as well as its presentation in influencing how they viewed mathematics. The students are quoted as saying:

**Student 3:** *“I preferred word problems and scenarios, they made understanding of the problem very easy for me”*

**Student 9:** *“We were given sweets to count and as motivation, we would eat them afterwards, and no hard terminology was used. Everything was explained in simple language and we were given attention”*

**Student 10:** *“It all depends on how the programme is structured...A good teacher and other materials makes following maths easy. It is all about background”.*

**Student 6:** *“It was word problems like Johnny had three apples, gave two to his friends and how many did he remain with?...that made the subject interesting and so we passed”*

What emanates from these responses is that the students believed that the success of the transference of the mathematical disposition lies in the teacher's ability to deliver the content in a way that was commensurate with the students' everyday language and social practices outside of the classroom. This included the use of word problems and imagery as that was the practice they were accustomed to. The students claimed that this made understanding and the connection of mathematical applications to real life, easy and interesting. Learning environments that trigger the students' interest according to Entwistle, Wood, Smith and Petocs (2002:9) yield positive learning outcomes. Swidler (1986) asserts that "interest is the engine of human action". The different strategies that teachers use to present mathematics content can be theorised using Bourdieu as follows: Although mathematics teachers share the mathematics habitus, during classroom practice they do not employ the same strategies and approaches in teaching but they do share a collective understanding of the basics of the subject. The approaches and strategies that teachers apply in teaching are informed by their individual habituses, socio-cultural conditionings and their ability to be innovative in presenting various mathematical scenarios as content changes. In Bourdieu's distinctive language, "the structure of the objective relations between the positions that agents occupy in a relatively autonomous field and the feel of the game" explains the different strategies one teacher employs from the other (Mois, 1991:1022).

In their responses, the students associated the use of imagery, incentives and word problems with primary school and said that the approach had been different at high school where they had been encouraged to work independently. This therefore confirms that the meanings that students attach to mathematics change with changes in learning environments. The students' discomfort with the changes in teaching approaches as they progress through the educational trajectory suggests a developmental problem. The use of word problems and imagery in primary school is developmentally appropriate for students at that stage. The change in presentation of problems at high school confirms the transformation that students' knowledge has to demonstrate as they progress through the educational trajectory and the different strategies and approaches needed to acquire that knowledge. The knowledge development stages that students are required to demonstrate are discussed by Entwistle (2004:411) in the literature. The student's responses therefore indicated a stagnant knowledge pattern. This perhaps explains their conception of mathematics as limited to arithmetic. Gomez Chacon, (2013:70) argues that "visual experience and images can trigger belief-forming dispositions," and this could perhaps explain the students belief that numbers are predominantly perceived

to constitute mathematical knowledge. In Bourdieu's (1998:81) interpretation, the imagery and word problems can be said to trigger the dispositions associated with the students' mathematics' meanings.

### 5.3.3 Teacher-Student Relationships

The students claimed that there was a decline in teacher support for them as they progressed from primary to high school, particularly mathematics teachers. They claimed that this led them to value mathematics less and they argued it was eventually expressed in their poor performance. The teachers were said to 'care less about them', 'less friendly' and focused more on those students who seemed to understand them. They were described as harsh and intimidating and dreadful. Some of the students are quoted as follows:

**Student 2:** "The mathematics teachers were dreadful. I was not comfortable and scared to ask. It seemed everyone understood maths except me and I accepted my fate that this is not for me".

**Student 3:** "*I had always been a good student in maths at primary but I started failing because the teachers were harsh and intimidating in high school. They went with those who passed and we were not given attention*"

**Student 8:** "*The Indians were the most brilliant in our mathematics class and they got all the attention from the teachers. I did not understand why because they did not need the help, we did yet we were ignored. Whenever you asked you were asked where you were the whole time and advised to seek assistance from your friends*"

Notably, not all the students characterise their mathematics teachers as described above.

Others described their relationship with their mathematics teachers as positive and thus made learning easier and enjoyable. However those who characterise their students as hard, intimidating and dreadful are understood to be saying that the teachers as sources of knowledge denied them access to the knowledge that they were entitled to by not giving them the support they needed to succeed. The need for teacher attention is in a sense, an acknowledgement of a lack of a competent habitus in mathematics by the students so that the teacher is used as a support prosthetic to pass mathematics. Midgley (1988:5) argues that such behaviour is typical of low achieving students as they derive motivation from teacher

support since their performance does not provide such an incentive, with the opposite being true for high achieving students as they do not look up to the teacher for motivation.

The teacher's behaviour, as student 3 asserts, also spells out power relations in the teacher-student relationship where the teacher has the authority to direct, redirect and structure the classroom environment in a way he/she deems appropriate in mathematics learning. The teacher overpowers the agency of the students as they have to put up with his/her way of operation. The power relation is translated to students' reliance on the teacher as the expert and is a constraint to the students' ability to apply themselves. In a way, the classroom is an extension of the socio-cultural norms and societal values where the social construction of adult-child relationship is authoritarian and dominated by adults. This shapes the way the students come to know and understand themselves as mathematics learners and their capabilities in the subject. As Swartz (2002:63s) explains in Bourdieu's theory, when individuals are in situations similar to ones that are encountered in their past experiences, the collection of meanings attached to similar circumstances are invoked and they act based on those meanings. The teacher's authoritarian position is similar to that of the nature of the students' interactions with adults outside the classroom to whom they are subordinate. Such unchallenged and unquestioned status quo of the power relations between the teacher and the students is referred to as the 'doxis social relations' by Mois (1991:1022). This means that the society's accepted and unquestioned norm sets the limits on what students as agents can and cannot do.

The connection between in-classroom and out-of-classroom practice confirms Haggis's (2003:94) assertions that the "personal meaning for the student may well be tied up with many aspects of life that are not closely connected to study". The socio-cultural norms and practices as observed in the classroom therefore attest to the continued interconnection between in-classroom and out-of-classroom social practice. Mois (1991:102) notes that there is an almost perfect connection between the class positions of the individual pupils and their teachers' intellectual judgments of them. The author argues that "defined as failures, students become failures in precisely the same way as the distinguished students become distinguished". The teachers' preference for some students over others therefore instils a sense of not belonging and doubt in their mathematical capabilities by the students that are not given the attention. This therefore explains student 5's perception that "*The Indians were the most brilliant in our mathematics class*" and thus given attention. On the other hand, the



students' preference of some students over others is a demonstration of how the education system rewards some cultural capital and not others wherein those who receive attention are the ones with the valued capital.

There is also a race undertone linked to the unequal treatment of the students which the students argued influenced their perception and conception of mathematics as a 'prestige thing'. The students' observation that in class 'indians' were given preference endorses Gaddies (2012:6) assertion that "not all households are equally privileged to succeed in the education system".

### **5.3.4 Teacher's perceptions of mathematics**

The significance of the teacher's perceptions in influencing students' conceptions and perceptions of mathematics lies in the element of co-creation of meaning in classroom practice. That is, the process of teaching and learning entails the sharing of meaning between the student and teacher which therefore renders the teacher's conceptions important to understand as they are expressed in the teaching and learning process. The students claim that in teaching, the teachers play out their own perceptions of mathematics which tends to be contagious and in some instances counter their efforts. This is quoted as follows:

**Student 1:** *"In fact I don't remember anyone struggling with mathematics at primary school, everybody did it - we were told it was important, have to know how to add just like you know how to read"*

**Student 9:** *"Maths teachers give the impression that maths is hard thus kids give up before they even fail. They should make students perceive it like it is any other subject"*

**Student 10:** *"It is like they knew that maths is hard so they had come to make it easy for us"*

**Student 2:** *"Teachers are dreadful. I was not comfortable, I felt scared to ask and it seemed everyone else around me understood it and so I accepted my fate that this is not for me"*

**Student 4:** *"The mathematics class brought me anxiety and I felt I knew nothing"*

The students shared the sentiment that the teachers endorsed a sense of an elevated status for mathematics from the rest of the subjects and that it is only accessible to a few students not all of them. The students claim that teachers expressed this by being hard on them as if to confirm that mathematics is hard. This suggests that teachers legitimise society's stereotype

about mathematics being hard, which makes for continuity in the negative collective consciousness about mathematics between classroom and out-of-classroom environments.

Where mathematics was treated as any other subject, the students admitted to having enjoyed and passed it. As Konings et al (2005:649) point out in the literature, “teachers perceive the learning environment through the lenses of their own conceptions, and will act and react accordingly”. This must be viewed in light of the fact that the teachers themselves are a product of the same society that lacks the mathematics habitus but had happened to crack the mathematics code either through exposure to a culture that is rich in the mathematics disposition or by applying themselves and mastering the tricks of the game through trial and error or by other means. It can therefore be said that, in teaching, teachers transmit the schemes of knowledge that make up their habitus. By virtue of the teachers being products of the same society that acculturates their students, they tend to anticipate stumbling blocks in their teaching and judge their students’ behaviour based on their schemes of knowledge about the subject as informed by their own experiences. This endorses Bourdieu’s (1990:86) claim that “an individual’s habitus is an active residue of his or her past that functions in the present to shape his/her perceptions”.

#### **i) Corporal punishment**

The students singled out some of the teachers’ actions that are perceived or conceived to have been as a result of the perceptions and conceptions teachers hold about mathematics. The students argued that a teacher’s perceptions are expressed through actions such as ‘dreadfulness’ and some disciplinary practices such as corporal punishment. This confirms the assertion that teachers act out the schemas of knowledge that inform their own experiences with mathematics during teaching. As noted in the literature, Naong (2007:284) argues that teachers claim that “they did not experience any harmful effects when corporal punishment was administered to them as students and they see no reason why they should not administer it to their learners as well”. Corporal punishment is thus a translation of the schemes of knowledge to a physical language about what counts as a corrective measure in mathematics learning. It could also be a way for teachers to vent their frustration about anticipated mathematics outcomes. This according to the students deterred most of them from liking mathematics, let alone pursuing it, as it was an uncomfortable situation to be in.

## ii) Ability Grouping

Ability grouping was also identified as an unfavourable practice in mathematics classrooms that students perceived and conceived would have a negative outcome to mathematics learning. Only two students attested to having been subjected to this practice but it is a notable factor as it was claimed by the students to have influenced their perception and conception of mathematics. One is quoted as saying:

*Student 1: “Undergrad social science students were mixed with pure science students for a mathematics class and science students were better mathematicians than we were. I felt out of place and felt I was not intelligent enough to contribute and grasp it. I was unable to cope and looking for an excuse and I was rescued by the split to do maths for social sciences”*

The mixing of science and social science students is a rare arrangement and was a Malawian experience. However, the underlying idea that the study explores is the mixing of students with distinctly varying mathematics comprehension levels. It has been described as over-selection by Lamont et al (1988:158 in quoting Bourdieu 1974). The author notes that this is where “individuals with less valuable cultural resources are subjected to the same type of selection as those who are culturally privileged and have to perform equally well despite their cultural handicap, which in fact means they are asked to perform more than others”. The mixing of the social science students in student 1’s response was thus a form of over-selection.

These sentiments were shared by student 2 as follows:

*Student 2: “Students who were poor in mathematics had their own class. It was discriminatory. We felt we were kids with special needs”*

Notably, student 2 was a foreign student who had done her high school in RSA. The practice of ability grouping referred to here was in high school in a RSA school. This contributes to students’ negative conception and perception of mathematics in that “naturally humans act to portray a desired identity” (Lamont et al 1988:158). It is evident from the two submissions that ability grouping is a social and physical environment that imposed an undesired identity, particularly for those students that were placed in low achieving classes as deconstructed from their submissions. The element of imposition of identity lies in the fact that they had no

choice in how they wanted to present themselves particularly those that were affirmed as less able or 'students with special needs'. As student 1 asserts... *we were mixed*.... which implies that it was not their doing nor was it a matter of choice. "It is in human nature to avoid scenarios that invite unwelcome self-definitions, and seek out and actively create situations that provide the kind of image they want to be associated with and desire" (Lamont and Lareau, 1988:158). This explains why the students perceived mathematics as not for them and thus were looking for an excuse not to do it, as confessed in their responses.

Students' self-elimination or self-exclusion has been identified as a normal reaction as Konings (2005: 653) argues that when humans find themselves in specific social settings that they do not feel at ease in or when they confront cultural norms that they are not familiar with, according to. This assertion has been confirmed by the students as follows:

**Student 6:** *"We were advised that in a test, we should not be stuck on the question that we are struggling with but move to those that we feel we can do. I did that with one test, kept moving through the sums until I got to the end. It was then that I decided that it's not for me and that some people are good at it and some are not.....and I am not"*

**Student 12:** *"In form 3 I started to spend longer time trying to solve mathematical problems yet others take shorter time. After a few attempts I still could not get it and I thought this is just not for me"*

The students' self-perceptions about mathematics have been summed up by student 4 who submitted that:

*"When you spectacularly fail, it is an indication that you belong somewhere else"*

From these submissions, the perceptions of students' ability mediated the relationship between perceptions of mathematics and mathematics outcomes in that students tended to eliminate themselves from participating in mathematics as an activity that they were not successful in and to adjust their aspirations to their perceived chances of success. The responses attest to the fact that the students' attempts to pass mathematics did not yield the desired results and thus adjusted their aspirations to alternative avenues where they had a chance of success.

### **5.3.5 Perceived Usefulness of Mathematics to Post Graduate Social Science Students**

The students responded as follows when asked whether they found mathematics to be useful to their studies and for their everyday application.

#### **5.3.1 The perceived usefulness of mathematics in their every-day-life.**

*Student 1: “We were told in high school that you were not educated unless you have maths and so I did it as a prestige thing. At university I lost interest because mathematics was not helping my career”*

*Student 2: “I continued to fail mathematics, I was just not interested.... Can’t see how half the things taught relate to real life”*

*Student 3: “I just did not see myself as a doctor or an engineer to which maths applied”*

*Student 5: “I knew it was just not for me and I am sure I disappointed my parents”*

*Student 7: “We did maths because we thought we would get good jobs, we were told it is a platform to a better life.*

*Student 11: “If it was not for the things we believed maths to be a platform to, I don’t think I would have done it”*

The perceived usefulness of mathematics is essentially a discussion of what kind of ‘affordance’ mathematics is to this study group. This is as discussed in by Bourdieu (1990:70) that meanings as an outcrop of culture provide a range of options on how students are likely to act. The study relates the perceived usefulness question to mathematics and of what value does it has for the students.

Most of the students admitted that they were given the best education their parents could afford and that they went to the best schools some of which they say were the best in town and white dominated. A majority of them had the privilege of private tutorship specifically in mathematics. This emphasises the willingness by the parents for their children to be associated with the ultimate culture. It is also an acknowledgement of the parents’ lack of the cultural capital that is valued in mathematics field and that parents have different perceptions of their roles in the transmission of academic capital, including the mathematical disposition, as noted by Masten (2006:211) in the literature. Henderson and Bellar (1994:29) however note that it is not every activity that parents do for and with their children that yields positive mathematics outcomes, but argues that parents must be prepared to act as teachers, assisting

their children with their tasks, reinforcing what was taught at school and supporting where they can. Asked whether they had any form of assistance with mathematics at home, it was concluded from their submissions that the parents involvement in the students' mathematics learning was very limited mainly due to the parents' busy schedules or their educational background is not mathematics orientated and alternatively engaged the services of private tutorship. For some students, the parents could not assist because they were not educated and thus the students were assisted by other classmates or siblings. This therefore emphasises the role of family in transferring the cultural capital that is dominant in the family.

Given the privilege of private tutorship specifically in mathematics, one would expect that those students would have excelled in the subject. However most of them did not. Instead it was those who had had no assistance at home or any form of private tutorship that succeeded in mathematics throughout their schooling and higher education. Those who said mathematics was of value to them were quoted as follows:

**Student 4:** "More time spent on working out mathematics problems, had to do preparations outside class... I even competed in a maths olympiad".

**Student 10:** "There was not a day that I would go to bed without having done some maths exercises.. It did me good"

Student

In other words, most of the students had been exposed to similar social, educational, economic and backgrounds that emphasised mathematics learning except for the few that worked their way up. It seems however that there is more to mathematics achievement than it being an entitlement to access the dominant culture. What this suggests is that there is a collision between agency and culture in determining learning behaviour and that is "culture is articulated in social behaviour and precisely social action" (DiTella and MacCulloch, 2006:9). The submissions suggests the differences in the human capital or cultural dispositions that are embedded in the students' habitus, which direct the student's learning behaviour to some ends and not others as Bourdieu argues.

The students' responses were also a clear indication of how socially defined meanings drive what society wants for the students or the students' parents as members of society. It seems from these responses that what the students study is influenced by what the teachers and

parents have found to be important for them such that the students' choice fits to what this network of social relations has defined as 'important'. As noted in how the students perceive the usefulness of mathematics for their ends, it is concluded that "the objective availability of opportunities is of little use for those who lack the suitable cultural equipment" (Swindler, 1986 as quoted by Rubenstein 2001:117). In other words, we may have similar aspirations in life but they are only achieved by those who have the cultural tools to actualise them.

Few of the study participants had assistance at home or any form of private tutorship yet they excelled in mathematics. They have attributed this to the continuous practicing of mathematical problems, as well as to preparation for class prior to the session at school. This endorses the literature in emphasising the positive effects of learning mathematics by doing.

The students admitted that, although there were those aspects of mathematical applications that they had found to be removed from real life, they could however make linkages between some mathematical applications learnt in class and their daily lives. There is also a recurring pattern that suggests an interconnection between students' perceptions of mathematics and the students' learning orientations. Learning orientations are described in the literature as "giving a 'personal context' to studying that includes a consideration of the person's aims, values and purposes for study" (Entwistle et al 2004:413). These responses confirm that the students had not done mathematics for themselves but they had done it because it had been driven as a ticket to great things. In other words, it was not perceived as useful in achieving the ends that the students had aimed to achieve. It is therefore not surprising that the students who did not apply themselves, regardless of privilege of private tutorship did not do well in mathematics. Parajes et al (1994:195) confirmed the consistency between students' perceived usefulness of mathematics and their performance. Mathematics clearly had no utility value for most members of this social group. They however do not dispute that it is useful generally.

### **5.3.2 The Perceived Usefulness of Mathematics to Post Graduate Social Sciences by the study respondents**

The quotes that are omitted are already represented in the quotes below. The students were quoted as follows:

**Student 1:** "Mathematics is relevant because it validates knowledge"

**Student 5:** “It is useful in research”

**Student 6:** “It is useful in quantitative research”

**Student 8:** “It is useful in statistical analysis”

**Student 9:** “It is useful because everything you do has some mathematical implications”

**Student 10:** “Stats and maths are really not that similar, you need the problem solving skills though”

**Student 12:** “In analysis but not hectic maths”

The students acknowledged the usefulness of mathematics in the social sciences as a subset of statistics or as a language in which statistical or quantitative research is delivered. Others chose to separate the courses as two separate entities. Generally, the usefulness of mathematics in the social sciences was acknowledged.

#### **5.4 Social support in Mathematics Learning**

To solicit what the structures of social support for the students were in mathematics, the students were asked indirectly to avoid the use of the term social capital. Rather they were asked what their coping mechanisms were with mathematical applications, and these were some of the responses of those who had social support;

*Student 1:* “We attended maths clubs where we were assisted and everybody could pass”

*Student 10:* “I asked colleagues and lecturers for assistance”

*Student 5:* “I had a study group”

*Student 6:* “We survived because of those study groups; otherwise we wouldn’t have seen the light of day”

Two issues emerged; Firstly, most of the students pointed to group discussions as a useful source of support in mathematics learning. The kind of support was information sharing to make it in mathematics. Notably, these were peer study groups organised by the students on their own without the assistance of the teacher. Secondly, the students viewed the study groups as an alternative to the traditional chalk and blackboard model and as a support group to the students. They were a source of social capital for the students as they benefitted from the cultural capital that existed within the group and that social capital is instrumental for the enhancement of human agency as detailed in the theory. This also affirms the discussion on meanings in the second chapter: that meanings come about through interaction. The group



discussions therefore were interaction with ‘others’ and with the mathematical symbols. They were also a process of alignment of individual meanings with mathematical meanings as social meanings.

Asked why the study groups were so helpful, the student’s submissions are summarised by student 5 as follows:

*Student 5: “You know, your friends would explain things in dumb-dumb terms and say ‘so and so this is how you do it... you take this and mix with that’ and so on and it makes perfect sense to you”*

This assertion has been endorsed by Vithal et al (2005:43) who argue that students prefer their peers compared to their teachers because their peers understand their thinking better. It is evident from the responses that study groups were not only a source of social capital but also a social space where students collectively constructed mathematical knowledge not in its typical symbolic language but as ‘social talk’. For some, it was a convenient excuse to escape their doubted mathematical capabilities, as suggested in the literature.

The students’ submissions suggested two sets of coping strategies: one of a few students who independently worked out mathematical applications and figured things out; and the other with most students reliant on study groups. The reliance on study groups as a coping strategy was a display of cultural capital where students are actively involved in their learning by seeking help from others and that they are aware that certain forms of knowledge can be accessed through structured patterns of interaction. It could also suggest a lack of independence by the students in carrying out operations that are expressed in the mathematics language as Gibbs (2010:2) asserts.

Notably, the students who admitted to relying on study groups overwhelmingly outnumbered those who were willing to try things out independently. Vithal et al (2005:44) note in the literature that although peer study groups are meant to be a participatory learning approach, the downside is that there is usually one expert learner and he/she is the one who benefits the most as he/she teaches the other members of the group while the others follow and copy the answers, in the process exacerbating the culture of learning dependence. This could not be

confirmed by the study as the dynamics of the group discussions were not interrogated. It suffices that social capital is utilised to enhance human capital as Granovetter (1973) argues.

Students' preference for peer groups can be explained in Bourdieu's language as a 'strategy of action' produced by a culture of dependence and/or a collective construction of knowledge that disposes students that are accustomed to this culture to develop this cultural preference so that their actions follow that preference.

### **5.5 The Perceived Link between Mathematics and Statistics**

This question was asked in order to ascertain the students' understanding of these concepts, particularly the relationship between mathematics and statistics. The question was asked twice, but framed differently on the two occasions. The first time was at the beginning of the interview and later towards the end of the interview to see if students maintained their understanding of the relationship between mathematics and statistics.

The establishment of the relationship between mathematics and statistics is to ensure that the participants and I were on the same page in understanding statistics as a subset of mathematics. This was based on my assumption that as long as it is numbers, it is all mathematics to a lay person. My assumption was informed by Muijis's (2004:3) findings that even in statistics it is the mathematics underlying the statistical applications that students find complicated and frightening. My scepticism was allayed when students confirmed my assumptions as follows the first time the question was posed:

***Student 2:*** "Statistics uses tools from mathematics"

***Student 5:*** "Mathematics is an overall umbrella for statistics and statistics utilises the general understanding of mathematics to quantify or do anything numerical".

***Student 6:*** "Mathematics and statistics are the same for me, they are all numbers"

***Student 8:*** "Maths is the overall numerical umbrella. If you have a general understanding of maths you are able to quantify or do anything numerically related"

***Student 10:*** "Mathematical background is needed for one to be able to carry out statistical applications"

There was a general consensus in the responses that as long as it is numbers it is mathematics, at least at the initial stages of the interview. All the students were found to view mathematics and statistics as both dealing with numbers and as seeking to find solutions to problems in the social environment. The students also made submissions to the effect that statistics was ‘upgraded mathematics’. Others argued that statistics borrows its applications from mathematics and is thus linked on that basis.

While there was general consensus at the beginning of the interview that as long as it is numbers, it is mathematics, the students’ language changed when we discussed mathematics in higher education. I got the sense that they regarded statistics as ‘lower grade mathematics rather than mathematics’. Statistics did not have the aura that surrounds mathematics. These were some of their quotes:

***Student 1:*** “*I actually prefer statistics to mathematics because it solves real life problems*”

***Student 2:*** “*Statistics was better than mathematics because it is not numbers all the way, you occasionally have scenarios*”

***Student 5:*** “*It would be unfair to judge my statistics capabilities based on my mathematics competency*”

***Student 8:*** “*In quantitative research, you encounter statistics as you go along and not that you necessarily doing stats*”

The submissions suggest a shift from conceiving statistics as a subset of mathematics to statistics as a stand-alone course with little mathematical applications. This attests to the ever-evolving social plane, the reflexive nature of meanings and inconsistency in meaning attribution. Most of the students also insisted that their mathematics competency had nothing to do with their statistics competency.

The shift in meaning confirmed McLeod’s (1992:580) argument in the literature that, “there are many different kinds of mathematics as well as a variety of conceptions about each type of mathematics”. To accommodate this shift in meaning where statistics is ‘this other type of maths’ with its own conceptions, the study investigates the conception of mathematics not directly, but as “an already existing conception or perception to a new but related task” (McLeod, 1992:581). Statistics and other quantitative applications are the new but related task to mathematics in this case. The students regarded themselves to be better in statistics

than mathematics because the mathematical applications were manageable in statistics. In other words, they maintained that their conceptions and perceptions of mathematics had little effect on their performance in statistics as they viewed the two subjects differently. In applying Bourdieu's theory, it can be said that statistics does not invoke past encounters that are similar to those experienced with mathematics and thus the meanings that are attached to mathematical operations underlying statistics are a new set of meanings with no association with the past (Swartz, 2002:63s) . There is thus no transfer of the know-how, skills and tactics on how similar situations were handled in the past to handling present situations in a similar way (Swidler 1986:277).

These findings seem to challenge Gibbs' (2010:2) assertion that students are unable to undertake quantitative work independently because the concepts in quantitative work are mostly presented in mathematics language as not true for this social group as this sentiment was shared by most of the students. The students seem to suggest that the mathematical content in statistics is not intimidating because it is minimal.

## **5.6 Conceptions and Perceptions of Mathematics in Prefiguring Educational Choices**

While the students maintained that their conceptions of mathematics had no direct effect on their performance on quantitative work, the study pursued this assertion by directly exploring their conceptions and perceptions in relation to the research methods for their studies. The students were asked two questions to establish whether their perceptions and conceptions prefigured their educational preferences and choices. One was why they pursued social sciences and the second was which research method they are using for their current research and why. They are quoted as saying:

***Student 1:*** "I was rejected in pure sciences because my maths was not strong-these were childhood ambitions- no regrets"

***Student 2:*** "I was not good in mathematics and therefore eliminated my wishes to do science"

***Student 3:*** " I wanted psychology undergraduate and policy and development at post graduate level and they happened to be in the social sciences"

**Student 7:** *“My results in maths were not so good so I wanted a theory based discipline. I like helping people”*

**Student 8:** *“Am interested in human behaviour, want to understand situations than formula”*

**Student 9:** *“I like history and geography and so the social sciences won me over”*

**Student 11:** *“The registration process for the social sciences was swift than the commerce that i wanted thus registered with the social sciences”.*

An array of factors led to the students’ registration for the social sciences were submitted. These range from time factor (meeting deadlines), personal preferences, default and by design. One of these factors is an acknowledgement of an unsuccessful attempt to pursue mathematics majors which was shared by some of the participants and particular interest is given. The responses where the students acknowledge failure to pursue pure sciences gives the impression that those students are found in the social sciences as an adaptive response to the determining nature of the system of learning or as an available alternative to the hard sciences. In other words, for these, the choice of the social sciences as a major is aligned congruently with the lack of mathematical disposition and as a convenient alternative avenue to hard sciences. It is also adaptive in the sense that as soon as students realise that they cannot be accepted in the hard sciences or struggle with mathematics, they adjust their aspirations to match their perceived abilities and the social sciences happen to be a match for their perceived abilities and opportunities.

### **5.6.1 Students’ Conceptions and Perceptions of Mathematics in Prefiguring their Choice of Research Methods**

**Student 3:** *“I chose qualitative methods because I wanted to keep away from calculations. I like narrating that’s why I chose qualitative research. The topic also required qualitative methods”*

**Student 7:** *“I appreciate the fact that I wasn’t to crack my head over maths that I was lazy to do. But for the good of society and the demands of work place. Figures make more sense if you understand them deeply. You tend to underestimate what you are required to do if you lack understanding”.*

**Student 8:** *“Using qualitative methods because I need to get understanding what motivates people to act and that cannot be answered through quantities”*

**Student 4:** “Want both because topic determines that. I am now more aware of the value of maths and maths treated me good”

**Student 5:** “Triangulation because the topic requires triangulation –people are my x and y. I still have a horrible attitude towards maths though”

**Student 6:** “Qualitative because of nature of the study”

The responses on the choice of research methods was a combination of all the research methods as reflected in the responses above. Most students were using the qualitative method. They were quick to explain that they were not evading quantitative methods and that “it is because of the nature of the study”. Most of the students who use qualitative methods voiced their preference for qualitative research over quantitative research and there was no admission of a struggle with the mathematics underlying quantitative methods.

The fact that ten out of twelve of the students were using qualitative analysis is particularly astounding. The students’ confession to preferring qualitative research over quantitative research is understood to suggest that in some cases people act in favour of their perceived chances of success in social contexts and that people are aware of their strengths and weaknesses and thus hardly pursue success in areas where they know they are not competent or in a “world where the accepted skills, style and informal know-how are unfamiliar” is according to Swindler (2007:274). I argue that although the nature of the study may influence the choice of research method to be used in acquiring the required knowledge, the final decision on which method the researcher uses is filtered through the subjective experience and opinion of the researcher. This assertion is well articulated by Ozbilgin et al (2005:859) in arguing that “any scientific endeavour is established on the assumptions made by the researcher regarding the nature of reality (ontology) and scientific practice (epistemology and methodology)”. The students’ “it is the nature of the study” response is attests to the fact that; “although individuals make choices, they do not choose the principles that govern these choices...and such is the role of objective structures in setting limits to agents' choice of goals” (Ozbilgin et al., 2005).

## **5.7 Mathematics Curriculum Changes’ Influence on Students’ Perceptions and Conceptions**

The South African mathematics curriculum changes, particularly the introduction of mathematics literacy as discussed in the literature, are articulated to have influenced the students' perceptions and conceptions as follows:

*Student 3: "Pure maths was hard and was failed. The beatings were also unbearable then I took mathematics literacy"*

*Student 5: "I chose maths literacy at high school because I didn't see myself being a doctor or an engineer. Maths was hard"*

It was established that all the students had done mathematics throughout their primary and high school education and some aspects of mathematical operations in higher education, particularly at post-graduate level. All the students had done higher grade mathematics at high school except two who did mathematics literacy. The reasons advanced for opting for mathematics literacy were captured as above. The students' responses seem to suggest that mathematics literacy was a convenient alternative to stick to their comfort zone, although they did not excel in mathematics literacy either.

This can be interpreted to mean that the introduction of institutional reform is an attempt to reorganise the students' perceptions and to induce an alternative habitus towards mathematics. As Daniel, Habib and South-Hall (2003:275) argue in the literature, most of the mathematics curriculum reforms were not successful. This confirms how habitus is resistant to change and that, while structural adjustments are implementable, adjusting habitus to match the coordinates of the structural adjustments is easier said than done. As Bourdieu refers to habitus as the structured structure, changing habitus therefore means 'un-structuring' parts of the structure and replacing them with parts that make up the desired habitus. It entails "alteration of concepts and exchange of old concepts for new ones as students learn new facts such that what was formerly important becomes unimportant and vice versa." (Rubenstein, 2001:82). The few students who cope well with structural adjustment can be understood in light of Swartz (2002:63S in quoting Bourdieu) in the theoretical framework that: "individuals possess the ability to be introspective and reflective of their actions in varying degrees".

## 5.7 Conclusion

Three key aspects are salient in relation to the social science students' conceptions and perceptions of mathematics. Firstly, most of the students have a narrow conception and perception of mathematics which explains their experience with mathematics learning and consequently how they performed in mathematics. The students' submissions suggest that they only a few of them possessed the valued cultural capital in mathematics learning.

It transpires that not only do the students' conceptions and perceptions influence their performance in mathematics but also mathematics influences their conceptions and perceptions towards it. Failure has been found to reinforce negative perceptions and conceptions related to their mathematical capabilities while success or a pass reinforces positive perceptions and conceptions towards the subject. This relationship between mathematics and the students' perceptions and conceptions prefigures the students' sense of place in mathematics learning and this is expressed through their performance, educational preferences and choices. The role of the familial habitus has been acknowledged by the students but has not been a source of support for this study group. Study groups have been found to be a source of support where the students shared knowledge and acquired some. This arrangement was said to be preferred by the students as it offers an alternative to the formal chalk and chalkboard arrangement and that knowledge among the students themselves is shared in everyday language which was referred to as 'dumb dumb' terms.

It surfaced that while mathematics enjoys a key position in the dominant culture status, these students pursue alternative avenues upon realisation of this barrier and social science is one such alternative for many of them. The findings indicate that the various ways indicated in the literature section on how students conceive and perceive mathematics has been confirmed to be true and that this linked to self perception and

It also emerged that students cope with the mathematical content in statistics because it is minimal, however indicating that qualitative research is their preference of choice and most of them use qualitative research for their current studies not because they are evading quantitative research but because of the nature of the study..



## CHAPTER SIX: RESEARCH CONCLUSIONS

### 6.1 Introduction

The study maintains that the meanings that students attach to mathematics as a social context, social activity and social object either aligns them or misaligns them with the competencies, skills and know-how that define proficiency in mathematics. In particular, the meanings structure how students are likely to act and engage with the mathematical habitus in learning. The success or failure of this engagement is expressed in how the students perform in mathematics. This is to say that students' poor performance in mathematics outcomes are a reflection of the societies that the students are a product of, a demonstration of the distribution of cultural capital in society, as well as an expression of valued and subordinate cultures in society. The varied meanings that students attach to mathematics also attest to the fact that meanings are not defined or crystallised within one articulation.

The field of education is thus a social plane where such a variance in the distribution of cultural capital in society is displayed. The study identified the UKZN social sciences to establish the meanings that post-graduate students attach to mathematics and how these are played out in how the students perform in mathematics and applications with mathematics as the underlying method. This follows Gibbs's (2010:2) and Edling's (2002:200) assertion that students enrol for the social sciences with the hope that they will have nothing to do with mathematics and that once enrolled, they do not cope well with the mathematical applications as they cannot undertake mathematics applications independently. The study also establishes the social, economic or cultural factors that mediate in the subjective/individual meanings and the possible influence this may have on the chosen research methods approach in their studies.

By identifying the underlying connection between conceptions and perceptions as meanings and learning outcomes and the socio-cultural factors upon which the conceptions and perceptions are embedded, the study contributes an understanding of the dynamics involved in the production and reproduction of social difference as expressed in the differentiated students' performance in mathematics. It is also a starting point in addressing students' poor performance in mathematics as a social problem because success in addressing a problem starts with an understanding of the problem and its intricacies.

The study explores the following research questions:

- What are post-graduate social science students' conceptions and perceptions of mathematics?
- Why do post-graduate social science students interpret mathematics the way that they do?
- To what extent do post-graduate social science students' conceptions and perceptions of mathematics influence their choice of research method for their post-graduate studies?
- What is the perceived usefulness of mathematics in post-graduate social science studies?
- What is the relationship between post-graduate social science students' conceptions and perceptions and mathematics outcomes?

## **6.2 Summary of Key Findings**

The research findings are based on accounts given by twelve UKZN post graduate (Masters and PhD) students in the School of Social Science. Although this might seem tentative, the accounts suggest important factors in understanding the interrelationship between students' learning behaviour, the socio-cultural factors that influence such behaviour and their conceptions and perceptions as meanings and mathematics outcomes. The following three issues are therefore salient for this study.

### **6.2.1 How Post Graduate Social Science Students Conceptualise Mathematics**

The study has defined mathematics as an activity that expresses solutions to social problems by using a communicative and instrumental system of symbols as means of articulating the solutions (Godino and Batanero 1993:8; RSA Department of Education 2011:8). The findings of the study indicate that students conceive mathematical meaning in qualitatively three different ways namely:

- a) The meanings attached to mathematical symbols
- b) The meanings attached to the value of mathematics
- c) The meanings they attach to their own mathematical competence

The link between these conceptualisations has been found to begin with an interaction between the student and the mathematics symbols. This has been termed a collision between the human habitus and the mathematics field. The field legitimises those forms of capital which the students possess (Benson, 2006:190) or which are embedded in the students' habitus. An evaluation of the valued capital by the field results in the valued cultural capital rewarded by the system and unvalued cultural capital punished by the system. The cultural capital a student possesses is a reflection of the dispositions embedded in their habitus and thus a reflection of who the students are, what they are competent in and what their preferences are. Their habitus as expressed in their competencies as evaluated by the education system is the lens through which they come to understand themselves and their capabilities and thus attach meanings to their own competence.

### **6.2.2 The Relationship between Conceptions and Perceptions and Mathematics Performance**

Although the study set out to establish how students' conceptions and perceptions influence mathematics, a one directional relationship between the concepts, the study concludes that there is a reverse relationship between the concepts. This is where students' performance in mathematics can in turn influence how students perceive and conceive mathematics. The study however does not explore this reverse relationship or how the concepts reinforce one another in the study as it was a finding and a confirmation of the existence of such a relationship existence which can be explored by future studies.

### **6.2.3 Cultural Mismatch between Classroom and Out-of-Classroom Practice**

The continued differentiated mathematics outcomes, with some students performing poorly while others are competent in mathematics, is a reflection of the cultures that the students are a product of. That is to say that the mathematics learning enterprise is interpenetrated and influenced by a complicated web of social relations, socio-cultural perspectives and epistemologies which underpin classroom practice, trends and approaches to teaching and learning. These include teachers' perceptions and public narratives about mathematics classroom practice such as teaching methods and corrective measures, among others. These socio-cultural dynamics channel students into certain ways of perception and conception and not others, as well as how students are likely to act and react in various teaching and learning

social contexts. It also emphasises the role of these social contexts and dynamics in the establishment of students' subjective identity and the perception of their mathematical capabilities. The study has found perceptions and conceptions to serve a dual responsibility. Positive perceptions have been found to be a platform to mathematics proficiency and negative perceptions have been found to be a stumbling block and to be associated with poor mathematics performance.

Continuity between school and out-of-school activities includes the need for a home environment that offers support, empowerment and motivation of students' educational pursuits. For instance, where the teacher is the guide and support at school, the family or parents should be the guide and support at home. The parents are to reinforce what was learnt at school or make a follow up on their children's academic progress, following Henderson and Belar's (1994:29) assertion in the literature that not all activities that parents do with their children amount to academic achievement but hands on involvement in their children's learning in particular. This suggestion is cognisant of the fact that not all families are structured or positioned equally to provide such support and motivation. Where such support is not available therefore, continuity can be ensured by the student taking the initiative to seek knowledge actively by engaging independently with the mathematical applications through practice in class and out of class regardless of the familial standing. This has been confirmed to work for those students who had no familial or parental support.

School therefore serves as a social plane where society's cultural dispositions are displayed. The value of students' know-how, skills and competencies as cultural tools is validated as the students engage with the mathematics habitus as society's dominant culture. Students are therefore regarded as poor in mathematics because they lack the cultural know-how, skills and competencies required from them by the mathematics habitus in order to succeed in mathematics learning. This confirms Bourdieu's assertion that not all families are equally positioned to access the mathematics habitus.

#### **6.2.4 Reshaping the Structural Formations that Inform Habitus**

This discussion follows the findings that address the question of what the factors are that inform students' perceptions and conceptions. Having asserted the existence of a gap in the interaction between school and out-of-school fields, there is need for a change in these

formations. There needs to be a change in the socio-cultural practices and epistemologies that pattern society's knowledge constructions, habits and view of how the world naturally works. The argument is that it is these structural formations in society that mark the limits of the human habitus and prefigure people's sense of place in society. Shifting the boundaries therefore would allow for the 'dance of agency' or easier engagement and compatibility of the human and school habitus. This holds true for the structural adjustments that are implemented in the education system: that any curriculum changes that ignore changing the social environment as a key structuring factor on which parents and teachers' conceptions and perceptions as well as students' competencies, skills and knowhow are embedded, is a futile endeavour. This is because teachers, parents or family and children have been identified as key players in mathematics learning. Putting mathematics into everyday language would make it accessible to students.

#### **6.2.5 Student's Active Participation in their Own Learning: Transcending Structural Boundaries in Mathematics Achievement**

Reshaping and restructuring the social environment and habitus is easier said than done. The study has demonstrated how some of the students managed to 'crack the mathematics code' by creating their own social space to engage actively in their own learning. Although they are few, they are however a force to reckon with. Fields as "arenas of struggle in which individuals and organizations compete, unconsciously and consciously, to legitimise those forms of capital which they possess" (Benson, 2006:190) essentially means that students are to be active players in the field and make some effort to meet the required standards of the game. As noted in the literature, mastery is not the first stage in knowledge development and thus students have to develop some patience and resilience as they learn and to make a conscious decision not to back down. Having noted how perceptions and conceptions can either be a stumbling block or a stepping stone in learning, perceiving mathematics as do-able is the starting point in transcending the cognitive and socio-cultural limitations to mathematics achievement, as all of reality filters through the body of the perceiver.

#### **6.3 Theoretical and Methodological Implications**

Bourdieu's theory of social practice is an ideal framework in capturing the multifaceted nature of the mathematics poor performance problem and how it is produced and reproduced.

Coupled with social constructivism which emphasises the co-creation of meaning in mathematics learning, the theories capture the problem in a more rounded way. That is, they explain students as agents, the social environment as apportioned into fields and how fields and agents interrelate in explaining students' actions and learning behaviour. The limitation with Bourdieu's theory is that it distances itself from emphasising gender issues and yet gender differences cut across class and culture focused explanations. This therefore means that the study does not pay attention to the unequal representation of genders in the reproduction of differentiated mathematics outcomes and this could be taken up by future studies.

The study endorses the instrumentality of students' conceptions and perceptions in understanding students learning outcomes through the use of one-on-one interviews to access the individual's world. It however acknowledges that soliciting conceptions and perceptions can be a cumbersome endeavour as some participants have never reflected on some aspects of their social environment and social realities. Being caught off guard, the response is often limited in depth to qualify as a conception or perception. Future studies may explore the ethnographic route alongside the interviews to capture the dynamics that inform poor mathematics performance first hand and with much detail.

#### **6.4 Policy Implications**

By exploring students' mathematical lived realities, the study acts as a guide in policy initiatives that seek to design and effect mathematics instructional approaches that are informed by students' perspectives. In other words, the study is not only an academic endeavour but it also has some practical implications particularly in mathematics learning in so far as policy making is concerned.

#### **6.5 Recommendations for Future Studies**

Below are some of the recommendations for future studies as identified in response to some discussions during the course of this study.

Firstly, following on from parents having different perceptions on what counts as support for their children's educational success, there is a need for an investigation of what kind of

parental involvement is directly linked with students' achievement in learning generally and mathematics in particular.

Secondly, the emerging prominence in mathematics failure could be a suggestion that such failure is assuming a dominant culture status in society. What could be the implications of the educational standards being adjusted in assimilation to this culture of 'mediocre' mathematics performance -- taking into account the introduction of mathematics literacy? What are the implications of dominant cultures and sub-cultures existing alongside one another?

Thirdly, it is noted that there has been little change in the content of studies that investigate the variation in meanings students attach to mathematics. Such meanings consistency regardless of the shifting time periods is a suggested research area that can be explored by future studies.

The establishment of mathematics conceptions and perceptions in the social sciences is admittedly a risky but worthwhile endeavour, particularly the mathematics in a statistics territory. This is regardless of literature confirming that the statistics that is used in the social sciences is not the students' favourite because of the mathematics language that underlies the statistical applications. Even though it makes logical sense to investigate mathematics in this situation as the causal factor behind students failing courses with mathematical applications (Muijis, 2004:3; Babbie, 1998:458; Gibbs, 2010:2), it is however suggested that future studies must anticipate shifts in the goal posts by the research participants in situations that invite undesired images or situations that portray the participants' lack of some cultural capital, as experienced by this study. To safeguard against such shifts, similar studies must accommodate the possibility that conceptions and perceptions can be investigated as "an already existing conception or perception to a new but related task" (McLeod, 1992:581).

Although phenomenographic studies emphasise on a small study sample, future studies should ensure a limited but representative sample to allow for a proper representation of all sexes, genders, ages, races and so on.

Lastly, it is suggested that future studies go beyond the one directional relationship where conceptions and perceptions influence mathematics to how the concepts reinforce one another.

## **6.6 Conclusion**

The various disciplines that students enrol for are well structured to cater for the distribution of the cultural capital in society and are well aligned with the cultural know-how, competencies and skills that students possess. However, there seems to be an emerging pattern of the interdisciplinary nature of the fields which poses a challenge to the 'bounded nature' of fields. The resurgence of mathematical applications in the social sciences is a case in point. This challenges students to embrace other knowledge domains and be reflexive in their approach to learning instead of pigeon-holing their focus and externalising some knowledge domains. We are living in an age where, although we are masters of some, we should also be jacks of all trades. As it is, the study group under investigation has admitted to be poor in mathematics but claims to cope with the mathematical content in statistical applications particularly because the mathematical content is minimal. They are however inclined towards their preference for narratives as an area of their perceived competence, over numbers and symbols.



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## **Appendix 1: Questionnaire/Research Instrument**

### **Post Graduate Students' Conceptions and Perceptions of Mathematics- A Study of Social Science students at the Pietermaritzburg Campus, University of KwaZulu-Natal**

#### **A) Meanings**

1. In your understanding, what is Mathematics?
2. What comes to mind when you think of the following words/ concepts
  - a) Statistics
  - b) Quantitative research
  - c) Qualitative research
  - d) Research methods
3. a) In your view, is there any relationship between mathematics, quantitative methods and statistics?
  - b) If so what is the relationship?

#### **B) Experiences and Views: School**

1. Thinking back to your primary and high school education-did you do mathematics and in which grades/form/standards?
2. a) Thinking back to your experiences at school-then-What was your perception about mathematics.
  - b) Did you think mathematics was a relevant subject to real life? Why?
3. Describe your experience/s with learning and understanding mathematics at school? How would you characterize this experience/s (e.g. happy/ uncomfortable)?
4. a) Relate one incident that was either negative or positive for you in a mathematics class.
  - b) Did it have any impact on your perception of mathematics?
    - c) If so how?
5. Did you receive any assistance with your mathematics homework at home? If so by who?
6. a) Are there any activities that you can recall that had some mathematical association, growing up?
  - b) Which are those?
    - c) Did you link it to the mathematics in class?
      - d) How so?
        - e) If not, why not?
  7. How would you describe your mathematics competency (poor, average, good and excellent)? Why?

#### **C) Experience with Mathematics Learning and Teaching**

1. How would you describe the students' mathematics performance generally throughout the schooling levels in RSA?
2. How would you describe the teaching method (s) employed to teach maths at different levels of the schooling system?
3. a) Reflecting on your school experiences, do you recall some teaching approach(s) or strategy (s) that helped you best enjoy/pass mathematics?
  - b) Which one was that?
4. What do you think determines one's success in mathematics?
  - a) Looking at your experiences with mathematics, is there anything you would change?
    - b) What would that be?

#### **D) Experiences and Views: University**

1. What determined your choice of the Social science as a discipline?
2. How would you describe your mathematical expectations when you enrolled for a Social science degree (undergraduate and postgraduate level)
3. How did you select the modules/courses? Or did the mathematical content of some of your courses influence your choice of modules?
4. a) Have you done any quantitative research modules?  
Were there any that you had to choose from?
- b) Have you done any statistics modules?  
Were there any that you had to choose from?
  - i) How did you find the mathematical content of these modules?
  - ii) Do you or did you have any strategy to pass the modules with mathematical content?
  - iii) What was that strategy?
5. Do you think your earlier views and experiences of mathematics have had an effect on your performance in mathematics and mathematics based methods like statistics and quantitative research methods. If so, How?
6. a) Tell me about your current research-which research method have you used for your research?
- b) What determined your choice of **research method**?

#### **E) Learning approach**

1. How would you compare your outlook at mathematics then (primary and high school) and now?
2. Looking at your experience/s with mathematics, what has influenced or continues to influence the way you view mathematics now?
3. Do you think mathematics learning allows for creativity or is static? Explain?
4. a) Do you think mathematics has any significance/ relevance in post graduate social science studies?
- b) If so, what is its relevance?
5. If you had to change or suggest anything about the mathematical content of post graduate social science modules, what would it be?
6. a) Now, as a post graduate student, do you think mathematics plays a role in your studies/research?
- b) If so, what is that role?
7. By the way, how did you define mathematics?

## Appendix 2: Humanities and Social Science Research Ethics Committee Approval



27 November 2013

Mrs Gama Vuyo Nomzamo  
School of Social Sciences  
Pietermaritzburg Campus

Dear Mrs Nomzamo

Protocol reference number: HSS/1295/013M  
Project title: Post Graduate Students' Conceptions and Perceptions of Mathematics-A Study of Social Science Students at the Pietermaritzburg Campus, University of KwaZulu-Natal

### Full Approval – Expedited

This letter serves to notify you that your application in connection with the above has now been granted **Full Approval**

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project; Location of the Study, Research Approach/Methods must be reviewed and approved through an amendment /modification prior to its implementation. Please quote the above reference number for all queries relating to this study. PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years.

Best wishes for the successful completion of your research protocol

Yours faithfully

Dr Shenuka Singh (Chair)  
Humanities & Social Science Research Ethics Committee

/pm

cc Supervisor: Sharmila Rama  
cc Academic Leader: Professor VN Muzvidziwa  
cc School Admin: Ms Nancy Mudau

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Humanities & Social Sciences Research Ethics Committee


Dr Shenuka Singh (Acting Chair)

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 1910 - 2010  
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: ■ Edgewood ■ Howard College ■ Medical School ■ Pietermaritzburg ■ Westville

## Appendix 3: Registrar's Approval to Conduct Research



9 September 2013

Mrs Vuyo Nomzamo  
School of Social Sciences  
College of Humanities  
Pietermaritzburg Campus  
UKZN  
Email: [212560218@stu.ukzn.ac.za](mailto:212560218@stu.ukzn.ac.za)

Dear Mrs Nomzamo

### RE: PERMISSION TO CONDUCT RESEARCH

Gatekeeper's permission is hereby granted for you to conduct research at the University of KwaZulu-Natal towards your postgraduate studies, provided Ethical clearance has been obtained. We note the title of your research project is:

*"Postgraduate Students' Conceptions and Perceptions of Mathematics – A Study of Social Science Students at the Pietermaritzburg Campus, University of KwaZulu-Natal".*

It is noted that you will be constituting your sample by randomly interviewing Masters and PhD students in the School of Social Sciences, College of Humanities, on the Pietermaritzburg Campus.

Data collected must be treated with due confidentiality and anonymity.

Yours sincerely

  
\_\_\_\_\_  
Professor J J Meyerowitz  
REGISTRAR

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#### Office of the Registrar

Postal Address: Private Bag X54001, Durban, South Africa

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## Appendix 4: Consent Form

### CONSENT FORM

#### CONSENT TO PARTICIPATE IN RESEARCH

**TITLE OF STUDY: SOCIAL SCIENCE POST GRADUATE STUDENTS' PERCEPTIONS AND CONCEPTIONS OF MATHEMATICS –THE CASE OF THE UNIVERSITY OF KWAZULU NATAL –(PMB CAMPUS)**

I am **Vuyo Nomzamo Gama**, a Masters in Sociology student at the University of KwaZulu Natal-(Pietermaritzburg Campus). I hereby request for your participation in my research. I seek to explore Social Science post graduate students' perceptions and conceptions of Mathematics. It is also in my interest to establish what informs these conceptions and perceptions. Your contribution will be by means of sharing your experiences, views and ideas through a face to face interview which should take about 20 to 30 minutes. The interview will be recorded for further reference during analysis.

Your participation is purely voluntary and no payment whatsoever will be received for participation nor is there penalty for refusal to participate. You may withdraw at any time during the interview should you feel uncomfortable with some of the questions asked. Your participation or lack of participation in this study will not interfere in any way with your studies.

Your names and identities as research participants will not be required for the study and all records of your participation will be stored, treated and disposed of with utmost security. Should you have any questions about the research at any time, please do not hesitate to contact either the following involved in the study:

Researcher:  
Gama Vuyo Nomzamo  
0836623514 (cell)  
Email: [212560218@stu.ukzn.ac.za](mailto:212560218@stu.ukzn.ac.za)

OR Research Supervisor  
Dr Sharmila Rama  
Room  
033 260 5188  
Email: [Ramas@ukzn.ac.za](mailto:Ramas@ukzn.ac.za)

Thank you very much.

**Appendix 5: Declaration**

**I..... (Full names of participant) hereby consent to participating in the research project on ‘Social Science post graduate students’ perceptions and conceptions of mathematics- The Case of the University Of KwaZulu-Natal (Pietermaritzburg campus).**

**I have confirmed that this study has received full approval by the Humanities and Social Science Research ethics committee and that it has been granted permission to utilize university space for the interviews. I also understand the contents of the consent information and the nature of the research project. I am aware that the discussions will be audio-recorded and I understand that I am at liberty to withdraw at any time, should I so desire.**

**SIGNATURE OF PARTICIPANT**

**DATE**

.....  
.....

.....



## Appendix 6: Editing Confirmation



### Editing Confirmation

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10/01/2015

Dissertation title: Post-graduate students' conceptions and perceptions of mathematics - a study of Social Science students at the Pietermaritzburg campus, University of KwaZulu-Natal

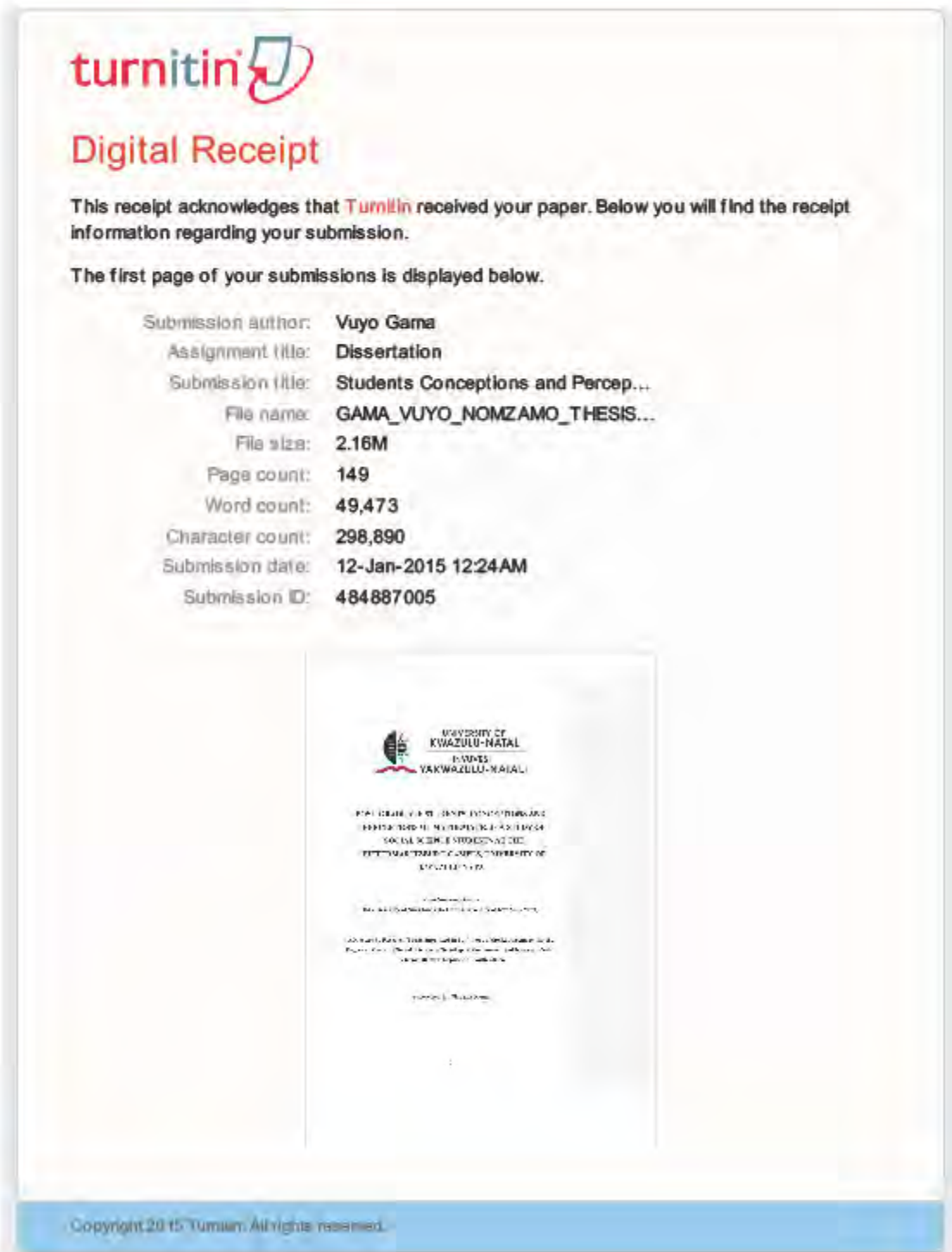
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This serves to confirm that the abovementioned dissertation was substantively edited by a member of the KZN Language Institute's professional English language editing team. Numerous tracked changes, corrections and suggestions were made, which the author was responsible to accept/attend to. Final proofreading of the document was not carried out by the KZN Language Institute. We thus cannot bear responsibility for the final version of the document.

Ms G. Coertze  
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