

**AN INVESTIGATION INTO THE PROVISION OF  
AUTHENTIC TEACHING AND LEARNING  
EXPERIENCES IN THE MATHEMATICS  
CLASSROOM**

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## DECLARATION

I, Mandosi Betty-Sarah Mrwebi, declare that AN INVESTIGATION INTO THE PROVISION OF AUTHENTIC TEACHING AND LEARNING EXPERIENCES IN THE MATHEMATICS CLASSROOM is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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## **DEDICATION**

This dissertation is dedicated to my son, Jojwayo Mrwebi, my family, friends and colleagues, who offered me unconditional love and support throughout the course of this study. I also dedicate the work to all those who supported me all the way since the beginning of my studies.

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## SUMMARY

The provision of authentic teaching and learning in the Mathematics classroom is one of the corner stones of the National Curriculum Statement (NCS). This study investigated to what extent teachers provide authentic teaching and learning in their Mathematics classrooms.

A literature study was undertaken to explain authentic teaching and learning. The use of teaching methods and strategies, learning activities, assessment methods and strategies, and the role of the teacher and learner in the context of authentic teaching and learning in the classroom were explored. The literature review provided the conceptual framework for the study; as well as the framework for designing questionnaires and an observation schedule. The questionnaires were utilized to obtain the perceptions of teachers and learners regarding opportunities provided by teachers for the provision of authentic teaching and learning experiences in the Mathematics classroom, and the observation schedule determined how and to what extent the principles of authentic teaching and learning were translated into practice.

Data was collected by means of quantitative, non-experimental descriptive survey research. The self-constructed questionnaires were administered to a convenient sample of a purposively selected group of Grade 4, Grade 5 and Grade 6 Intermediate Phase Mathematics teachers ( $n = 24$ ) and learners ( $n = 440$ ) in the Johannesburg South District of the Gauteng Department of Education. In addition to this, the classroom practices of six of the teachers who completed the questionnaire were observed over a period of six months.

The triangulation of teacher and learner data revealed similarities and differences in opinion related to the opportunities that teachers create for authentic teaching and learning in the Mathematics classroom. In essence, the data revealed that teachers who took part in the study apparently understand the principles that underpin authentic teaching and learning, and to some extent comply with the principles of authentic teaching and learning in their classrooms. In addition to this, the triangulation of the teacher

responses to the questionnaire and the observations of the classroom practices of the teachers indicated that in practice all the application of the principles of authentic teaching, learning and assessment have not yet fully become a reality in the Mathematics classroom. According to the learner responses, to the questionnaire, as well as the observations, it appeared that the application of teaching and assessment strategies that promote authentic teaching and learning are under-utilized by the teachers.

This study is concluded with recommendations to teachers on how to create classroom climates that promote the provision of authentic teaching and learning in the Mathematics classroom.

Key words: authentic teaching, authentic learning, authentic assessment, Mathematics education

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# CHAPTER ONE

## ORIENTATION AND STATEMENT OF THE PROBLEM

### 1.1 INTRODUCTION

Performance of learners in Mathematics, as measured in terms of test and examination results nationally, is poor (Kahn, 2004:149). The dismal level of achievement in Mathematics and the subsequent performance in Matric has been commented upon in many quarters such as the Department of Education, the media and the general public (Kahn, 2004:149-156). There is a perception that Mathematics is a difficult subject and consequently avoided by many learners (Kilpatrick, Swafford & Findell, 2001:18). According to Brodie (2004:66), the type of teaching that dominates Mathematics in the classroom of today's school tends to produce undesirable results, including leaving learners with the following impressions about Mathematics:

- that it is a boring sequence of technical vocabulary, rules and algorithms to be memorized for the purpose of passing tests in school;
- that it is a complex, mystifying subject that was handed down to us by some ancient mystics (from Greek mythology); and
- that only people with an exceptional aptitude for Mathematics can creatively do Mathematics.

In addition to this, Kassiem (2004:7) argues that disadvantaged learners from seriously impoverished learning environments are lacking in the necessary informal Mathematics knowledge prescribed by the problem-centered approach to teaching and learning Mathematics. Kassiem (2004:7) also asserts that learners are also not able to develop their own strategies for solving non-routine Mathematical problems in which the approach to solving the problem is not obvious from the context (Department of Education, 2003:28).

The problem-centered approach to teaching Mathematics is linked to the fact that the South African education system has been undergoing extensive restructuring since the

advent of democracy. Coinciding with the formation of democracy in South Africa in 1994, an Outcomes-Based Education (OBE) system was established. Introduced in 1998 and amended in 2001, this system is built on the premise that all learners have the ability to succeed and focuses on the acquisition of knowledge, skills, values and attitudes. According to this paradigm teachers are expected to bring real-life, authentic Mathematics into the classroom and help learners acquire skills that will prepare them to become life-long learners and critical thinkers (Maree, Aldous, Hattingh, Swanepoel & Van der Linde, 2006:230). That authentic teaching and learning have to take place in the Mathematics classroom, are also clearly highlighted by the National Curriculum Statement (Department of Education, 2003:34-44; Department of Education, 2002:4, 5) that underpins the teaching of Mathematics. The teaching of Mathematics should *inter alia* focus on a number of authentic teaching and learning principles (*cf.* 2.4.1-2.4.7), namely providing learners with challenging tasks through which they should obtain deep conceptual understanding of Mathematics, learners should negotiate meaning with their peers and teacher and solve problems related to their lives (Department of Education, 2003:23-24). The term authentic thus implies some notion of reality in terms of its purposes, methods and experiences arising from it. Rick (1998:2) and Cranton and Carusetta (2004b:7) identify the following features of authentic teaching and learning:

- Authentic teaching and learning demand that learners solve problems actively.
- In authentic teaching and learning situations, people work together. Authentic teaching and learning situations simultaneously involve one's knowledge, skills and attitudes.
- Authentic teaching and learning is driven by essential knowledge that is meaningful to learners.
- In authentic teaching and learning environments, activities are connected.
- In authentic teaching and learning situations, learners publicly exhibit their learning and there are often real life standards of quality.

Cranton (2001:4) defines authenticity as the expression of the genuine self in the community. She further describes teaching as a specialized form of communication that

has learning as its goal and points out that meaningful communication rests on the premise that those involved are speaking genuinely and honestly, rather than with the intent to manipulate or deceive.

According to the researcher, the aforementioned features link well with the constructivist approach to teaching and learning according to which learners learn when they are involved in active and interactive teaching and learning environments (Gredler in Epstein, 2002). The researcher therefore argues that teaching and learning environments should be based on constructivist principles in order to provide opportunities for authentic teaching and learning.

The role of the teacher is to provide a classroom full of interesting learning opportunities to encourage the learner to construct his/her own knowledge and to have the ability to explore. The classroom must give the learners the opportunity to construct knowledge through their own experiences (Epstein, 2002). There is less emphasis on directly teaching specific skills and more emphasis on learning in a meaningful context.

According to Kraft and Billig (1997:6) and Jobling and Moni (2004:6), authentic teaching and assessment experiences in a Mathematics classroom require learning contexts to be real and purposeful, motivational and practical in terms of the classroom environment in which Mathematics learning takes place. According to Jobling and Moni (2004:6), these authentic experiences can be achieved through:

- **construction of knowledge** which suggests that authentic learning experiences based on a foundation of prior knowledge must result in the learners' constructing or producing new knowledge;
- **disciplined inquiry** which consists of three major components such as a firm understanding of the prior knowledge base that has been accumulated in Mathematics, an in-depth understanding of Mathematics and elaborated communication as a proof of competence, involving complex expressions of ideas, justifications and explanation; and
- **value beyond school** which recognizes that most significant intellectual accomplishments are intended either to express one's unique ideas or to influence

others. These accomplishments have a value, both to the learner and to the intended audience. This value is often missing from the contrived Mathematics tasks such as quizzes, exercises and examinations presented to learners.

Research conducted nationally and internationally in the field of authentic teaching and learning revealed the following: a number of studies linked authenticity to authentic assessment in general (Darling-Hammond, Einbender, Frelow & Ley-King; 1993; Karges-Bone, 2000); assessment in the English language (Valencia, Hiebert & Afflerbach, 1994; O Malley & Valdez Pierce, 1996); assessment in Mathematics (Romberg, 1995) and authentic teaching in Higher Education (Cranton, 2001; Herrington & Herrington, 2006 ). Related national research studies that were conducted focus on the teaching and learning of Mathematics at school level with specific reference to a problem-centered approach and problem-solving in Mathematics (Van Biljon, 1997; Van Niekerk, 1997; Nieuwoudt, 2003; Graaff, 2005). No studies that focus on authentic teaching and learning of Mathematics in the Intermediate Phase could be located. In this regard, this study wishes to extend and contribute to the existing research on authentic teaching and learning by focusing on an investigation into the extent to which opportunities for authentic teaching and learning in Intermediate Phase Mathematics classrooms are created.

Based on the aforementioned discussion, it appears that Mathematics remains vulnerable to poor instruction in South Africa which does not yield good results. Mathematics is commonly presented at school level in a way that strongly encourages traits such as resistance, conformation to rules and the use of sophisticated language (Maree, 1999:467-476). Recent research has revealed that the vast majority of Grade 6 learners in the Western Cape (normally one of the top achieving provinces in South Africa) have not even mastered the literacy and numeracy level expected of Grade 4 learners (Kassiem, 2004:7).

From the foregoing paragraphs, the researcher concludes that authenticity should characterize the teaching and learning activities in Mathematics classrooms and that the absence of opportunities for authentic teaching and learning could be cited as a factor that contributes to poor performance in and negative perceptions of Mathematics. This

research therefore investigated to what extent teachers create opportunities for authentic teaching and learning experiences in the Mathematics classroom.

## **1.2 PROBLEM STATEMENT**

The failure rate in Mathematics at school remains unacceptably high (Kahn, 2004:149). Research indicates that many learners in South African schools do not master the knowledge and skills underlying learning and problem-solving sufficiently. Learners often acquire deficient, superficial and rote knowledge of basic concepts (Maree & De Boer, 2003:449). The latter could imply an absence of authentic teaching and learning in the Mathematics classroom.

Based on the identified problem, this research wishes to answer the following central question:

- To what extent do teachers create opportunities for authentic teaching and learning in the Mathematics classroom?

Within this central question the following questions arise:

- What does authentic teaching and learning entail?
- What are teachers' understanding of authentic teaching and learning in the Mathematics classroom?
- What are learners' perceptions regarding the application of authentic teaching and learning in the Mathematics classroom?
- How do teachers enhance the authenticity of teaching and learning in the Mathematics classroom?
- Is there a difference between learner and teacher responses regarding the extent to which opportunities for authentic teaching and learning are created in Mathematics classrooms?
- What recommendations can be made to improve the authenticity of teaching and learning in the Mathematics classroom?

### **1.3 AIM AND OBJECTIVES OF THE STUDY**

The overall aim of the study was to determine to what extent teachers create opportunities for authentic teaching and learning in the Mathematics classroom. The overall aim was operationalized as follows:

- by determining what authentic teaching and learning entail;
- by establishing teachers' understanding of authentic teaching and learning in the Mathematics classroom;
- by examining learners' perceptions regarding the application of authentic teaching and learning in the Mathematics classroom;
- by investigating how teachers enhance the authenticity of teaching and learning in the Mathematics classroom;
- by determining whether there is a difference between learner and teacher responses regarding the extent to which opportunities for authentic teaching and learning are created in the Mathematics classroom; and
- by making recommendations to improve the authenticity of teaching and learning in the Mathematics classroom.

### **1.4 METHOD OF RESEARCH**

#### **1.4.1 Literature study**

A literature study was conducted to gather information on the reasons for poor performance in Mathematics at schools as well as on what authentic teaching and learning entail. To achieve this, data bases (both national and international) were consulted during the study. An EBSCOHost web, ERIC and a DIALOG search were done. Recent primary and secondary resources were used to conduct the literature review. The following key words and phrases were used: *authentic learning environments, authentic teaching, authentic learning, performance in Mathematics and reasons for poor Mathematical performance.*

Table 1.1 indicates the broad themes that were identified in the literature review which were utilized to structure the discussion in Chapter Two and informed the construction of the questionnaires that were used to collect data.

**Table 1.1: Summary of themes identified from the literature**

<u>Theme</u>	<u>Journal</u>	<u>Books</u>	<u>Internet</u>
Conceptualisation of authenticity	Cranton & Carrusetta, 2004b	Mezirow, 2000 Cranton & Carusetta, 2001	
The Authentic teacher	Cranton & Carusetta, 2004a/b Cranton & Carusetta, 2006	Buber, 1961 Heidegger 1962 Jarvis, 1992 Brookfield, 1997 Sharp, 1995 Ray & Anderson, 2000 Palmer, 2000	
Indicators of authenticity in teachers			Cranton, 2006
Authentic teaching			Robertson & Fluck, 2002 Cranton, 2006
Teaching purposes			Robertson & Fluck, 2002 Cranton, 2006
Teaching methods and experiments			Robertson & Fluck, 2002 Cranton, 2006

<u>Theme</u>	<u>Journal</u>	<u>Books</u>	<u>Internet</u>
Authentic learning	Prawat & Floden, 1994 Rick, 1998 Rule & Hallagan, 2007	Arends, 2009 Gawe, 2007 Kukla, 2000	Anon., 2010 Gradgenett & Harris, 2007 Renzulli <i>et al.</i> , 2004 Hobart, 2005
Higher-order thinking	Cobb, 1995		Fox, 2001 Henry, 2002 Stewart & Brendefur, 2005
Depth of knowledge			Stewart & Brendefur, 2005
Connectedness to the world beyond the classroom			Stewart & Brendefur, 2005
Substantive conversation			Stewart & Brendefur, 2005
Social Support for learner achievement		Fosnot, 1989 Watts & Bentley, 1991 Fosnot, 1996 Gredler, 1997 Fraser, 2006	Hein, 1991 Brooks & Brooks, 1995 Cobb, 1995 Gray, 1997 Newman <i>et al.</i> , 1995 Gray, 1997 Epstein, 2002

<u>Theme</u>	<u>Journal</u>	<u>Books</u>	<u>Internet</u>
Authentic learning and academic challenges	Rick, 1998	Grosser, 2002 Borich, 2004 Kramer, 2006 Eggen & Kauchak, 2010	
Authentic learning and scenario challenges	Rick, 1998		
Authentic learning and real-life problems	Rick, 1998	Grosser, 2002 Kramer, 2006 Borich, 2004 Eggen & Kauchak, 2010 Sessoms, 2008	Grandgenett & Harris, 2007 Rule & Hallahan, 2007
Authentic Curriculum	Rick, 1998		Kraft & Billig, 1997
Authentic pedagogy			Newmann & Wehlage, 1995 Kraft & Billig, 1997
Authentic assessment	Rick, 1998 Mueller, 2000 Suurtamm, 2004 Darling-Hammond & Snyder, 2005 Mueller, 2005 Suurtamm, 2004	Herman, 1992 Chappius & Stiggins, 2002 Stiggins, 2002 Luongo-Orlando, 2003 Black <i>et al.</i> , 2004 Guilkers <i>et al.</i> , 2004 Davies & Waverly, 2005	Custer, 2000 Geyser, 2001 Mueller, 2005

<u>Theme</u>	<u>Journal</u>	<u>Books</u>	<u>Internet</u>
Sampling of actual knowledge, skills and disposition desired	Darling-Hammond & Snyder, 2005		
Requiring the integration of multiple kinds of knowledge	Darling-Hammond and Snyder, 2005		
Collection of multiple success of evidence	Darling-Hammond and Snyder, 2005		
Evaluation of assessment evidence	Darling-Hammond and Snyder, 2005		

## **1.4.2 Empirical research**

A brief explanation of the empirical research that was conducted will be provided in this section. Chapter Three provides a detailed elaboration on the empirical research design.

### **1.4.2.1 Research framework**

This research was built on a positivistic framework. The researcher aimed to evaluate the social world of the Mathematics classroom objectively through questionnaires and observations (Maree & Van der Westhuizen, 2007:33).

### **1.4.2.2 Research design**

In accordance with the research paradigm and in order to realize the aims of this study, a quantitative empirical research design was employed. In quantitative research, data are collected from a population, or from one or more large samples that represent the population in a form that is easily converted to numerical indices (Leedy & Ormrod, 2005:96). Quantitative research is a process that is systematic and objective in its ways of using numerical data from only a selected subgroup of a universe (or population) to generalize the findings to the universe that is being studied (Maree & Pietersen, 2007a:145). A quantitative research design was chosen as the researcher wanted to establish, explain and confirm a given situation in the Mathematics classroom by collecting objective numerical data (Leedy & Ormrod, 2005:96).

In the context of quantitative research, the researcher had to convince herself that the research complied with internal and external criteria for validity. It was necessary for the researcher to determine whether the research conducted in this study complied with the following validity criteria identified by Leedy and Ormrod (2005:97-99) and McMillan and Schumacher (2006:134-142), namely statistical conclusion validity, internal validity, external validity and construct validity. Each of these aspects is explained in Chapter Three.

### **1.4.2.3 Research strategy**

A non-experimental, descriptive survey research strategy was utilized in this research. This strategy is suitable for this research as this study entailed a first investigation and the researcher simply wanted to provide a summary of an existing phenomenon and assess the nature of existing conditions. No intervention took place (McMillan & Schumacher, 2006:24, 215). In addition to the survey research strategy, and as part of the descriptive research strategy, an observation study (Leedy & Ormrod, 2005:179) was conducted to provide a more holistic picture of the extent to which authentic teaching and learning opportunities are provided in the Mathematics classroom. The data obtained from the survey and the observations enabled the researcher to construct a complex and integrated picture of teaching and learning in the Mathematics classroom.

### **1.4.2.4 Population and sampling**

A population is a group of elements or cases, whether individuals, objects or events, that conform to specific criteria and to which we intend to generalize the results of the research (McMillan & Schumacher, 2006:119). The population of this research comprised all Mathematics teachers and learners. As it was not possible to do research with the entire population, a study population was identified from which a sample was chosen.

The study population that was used for this study purposively and conveniently comprised all Intermediate Phase Mathematics teachers and learners (Grades 4-6) in the Lawley/Ennerdale area of D11 (Johannesburg South) in Gauteng. The sample that was drawn from the study population was also convenient, as the researcher works in the Intermediate Phase in this particular district and has easy access to all the schools. There are 78 primary schools in this district. Due to time, financial and logistical constraints, the sample comprised of 8 randomly selected primary schools in this district ( $n=8$ ). This is in line with the views of Seaborg, Grinnell and Williams (cited by Vermeulen, 1998:59) that a 10% sample size in most cases is adequate to control for sampling error. In random sampling, all schools in the particular district stand a chance of being selected (Leedy & Ormrod, 2005:201). Furthermore, in random sampling, each member of the population under study has an equal chance of being selected and the

probability of a member of the population being selected is unaffected by the selection of other members of the population (Cohen, Manion & Morrison, 2007:110). A list of all primary schools was obtained from the district and the researcher randomly selected 8 schools from the list. As this is predominantly a Black and Coloured community, four of these schools comprised mainly Black learners and four comprised mainly Coloured learners. In each school, one Grade 4, one Grade 5 and one Grade 6 class and their respective teachers were selected to take part in the research. The selection of a class was based on the willingness of the teachers and learners to take part in the research. In total, eight Grade 4, eight Grade 5 and eight Grade 6 classes of  $\pm$  40 learners per class (boys and girls) ( $n = 960$ ) and 24 teachers (experienced and inexperienced) were selected to take part in the research. Ultimately, only 720 learners were willing to take part in the research. The learner sample comprised boys and girls, and the teachers sample comprised a heterogeneous group of teachers representative of different gender, age, teaching experience and qualification groupings (*cf.* 4.2.3). For the purpose of the observations, six willing teachers from the teacher sample were identified.

#### **1.4.2.5 Data collection instruments**

Questionnaires as well as observations were utilized for the purpose of this research. According to Leedy and Ormrod (2005:183), research by means of questionnaires involves acquiring information about one or more groups of people regarding their characteristics, opinions, attitudes, or previous experiences by asking them questions and tabulating their answers. As in the case of this study, the use of questionnaires was suitable for obtaining information about the opinions of a large population (Leedy & Ormrod, 2005:183).

Information from the literature study was used to develop and design two closed questionnaires, comprising similar Likert-scale items for teachers and learners respectively, to gather information on the opportunities for authentic teaching and learning in the Mathematics classroom. Self-developed questionnaires were used in this case as a standardized questionnaire was not available. The questionnaires focused on teachers' understanding of authentic teaching and learning and the practical application of authentic teaching and learning through teaching and assessments and strategies.

The learner questionnaire determined learners' opinions regarding the extent to which authentic teaching and learning are provided in their classrooms.

Structured observations according to predetermined criteria were done by the researcher and a co-observer to construct a complex yet integrated picture of how the teachers and the learners in the sample acted and interacted in the Mathematics classrooms (Leedy & Ormrod, 2005:179). The focus was on determining the frequency with which particular aspect of behaviour in relation to authentic teaching and learning occurred. Cohen *et al.* (2007:400) refer to event sampling in this regard. Observations were done with two randomly selected teachers from each of the groups of Grade 4, 5, and 6 teachers ( $n = 6$ ), and three observations of 30 minutes each were conducted with each of the teachers spaced over six months. In total, data were obtained for eighteen observations.

#### **1.4.2.6 Reliability and validity**

A pilot study was conducted with a group of fifty Intermediate Phase Mathematics teachers and fifty Intermediate Phase Mathematics learners of the population who were not part of the sample, in order to determine the reliability and validity of the questionnaire.

A Cronbach alpha coefficient was calculated to determine the reliability of the questionnaire. Validity of the questionnaire was determined by considering face, content, criterion and construct validity. Inter-item correlations were calculated to determine whether the questionnaire items in each section measured the construct in question. The results for the pilot study are reported in Chapter Four (*cf.* 4.5.1.7).

With regard to maintaining objectivity during the observation study, the researcher followed some of the guidelines provided by Leedy and Ormrod (2005:18). The behaviour studied, namely authentic teaching and learning, was defined in a precise and concrete manner so that it was easily recognized when it occurred. The researcher made use of a co-observer who was a colleague and was also involved in teaching Intermediate Phase Mathematics and rated the same behaviour independently from the researcher over a period of six months. This co-observer was trained by the researcher prior to the observations to be able to help in identifying and classifying the behaviour

under observation. A pilot study was done with three Intermediate Phase teachers of Mathematics who were not part of the sample to determine whether the aspects indicated for observation gave a true reflection of teaching and learning in the Mathematics classroom, and to check the time frame and ease with which the observation schedule would be implemented.

#### **1.4.2.7 Hypotheses**

As the researcher wished to determine whether there was a difference between the teacher and learner responses regarding the application of the principles of authentic teaching and learning, the following null and alternative hypotheses were formulated for the study:

$H_0$  = There will be no statistically significant difference between the learner and teacher responses regarding the application of the principles of authentic teaching and learning in the Mathematics classroom.

$H_1$  = There will be a statistically significant difference between the learner and teacher responses regarding the application of the principles of authentic teaching and learning in the Mathematics classroom.

#### **1.4.2.8 Statistical techniques**

In this study, descriptive and inferential statistics were used. The researcher wanted to provide a summary of the data by means of descriptive statistics (Pietersen & Maree, 2007a:185), but also wanted to go beyond summarizing and compare the data obtained for learners and teachers. For this purpose, inferential statistics were utilized (Pietersen & Maree, 2007b:198). The Statistical Consultation Services of the North-West University, Vaal Triangle were consulted for assistance. Frequencies, means and percentages were calculated for the learner and teacher responses to the questionnaires. To determine the significance of differences between teacher and learner responses, inferential statistics were used. T-tests were utilized to determine significance and Cohen's  $d$  was calculated to determine if the significance had any effect in practice (Pietersen & Maree, 2007d:229, 330). Data collected during the observations were rated for frequency of the observed behaviour (Leedy & Ormrod, 2005:180).

#### **1.4.2.9 Ethical aspects**

The following ethical aspects, as indicated by Leedy and Ormrod (2005:102), were followed:

- The prescribed research request form of the Gauteng Department of Education was completed and submitted to the Department for approval to administer the research questionnaire to the target population. Permission was granted to conduct the research (*cf.* Appendix A).
- After permission was granted, school principals, teachers, learners and their parents were consulted to obtain permission for the research (*cf.* Appendix B). Respondents were provided with a description of what their participation would involve, as well as a statement indicating that participation was voluntary and that they had the freedom to withdraw at any time if they wished to.
- The questionnaire was accompanied by a covering letter assuring respondents of the confidentiality with which their responses would be handled. Questionnaires were completed anonymously.
- An application to conduct the research was submitted to the Ethical Committee of the North West University for approval. Ethical clearance was obtained and the project received the certificate number (*cf.* Appendix C).
- Although the observations were conducted during teaching time, they were scheduled in consultation with the principal and teachers, and did not disturb the normal running of the teaching and learning activities.

#### **1.5 FEASIBILITY OF THE STUDY**

The study was feasible because there were sufficient literature sources available on the topic. The research was conducted in the Johannesburg South District where the researcher teaches at one of the schools, thus allowing for easy access to the research respondents.

## 1.6 CONCEPTS CENTRAL TO THE STUDY

A detailed discussion of the concepts central to the study is done in Chapter Two. In this section, the researcher provides a brief description of each of the key concepts to place the study in context.

- **Authentic teaching:** Authentic teaching is teaching that provides the learner with access to existing knowledge and support for enquiry (Cranton, 2006:29).
- **Authentic learning:** Authentic learning is learning that is defined as a social practice enabling learners to act knowledgably and powerfully in the classroom and the world (Kruger, Cherednichenko, Hodley & Moore, in Hobart, 2005:12).

Planning for assessment forms an integral part of teaching and learning (Department of Education, 2003:2), and the researcher therefore also investigated how authentic assessment takes place in the Mathematics classroom.

- **Authentic assessment** refers to assessment tasks and procedures in which learners are engaged in applying essential skills and knowledge to solve real life problems (Custer, 2000:3).

## 1.7 CHAPTER SUMMARY

This chapter presented an orientation to the study with the aim of preparing the reader for the subsequent chapters. The researcher envisaged examining the extent to which teachers create opportunities for authentic teaching and learning in the Intermediate Phase in Mathematics classrooms. Quantitative, non-experimental descriptive research by means of questionnaires and observations was conducted with Intermediate Phase (Grades 4-6) Mathematics teachers and learners in the D11 District of the Gauteng Department of Education.

The next chapter will elucidate the meaning of authentic teaching and learning linked to the Mathematics classroom.

## **CHAPTER TWO**

### **AUTHENTIC TEACHING AND LEARNING IN THE MATHEMATICS CLASSROOM**

#### **2.1 INTRODUCTION**

This chapter deals with a literature study based on authentic teaching and learning and provides an in-depth understanding of authentic teaching and learning. As classroom teaching should involve a coherent series of teaching, learning and assessment activities (Department of Education, 2003:12), this chapter aims to link authenticity to teaching, learning and assessment in Mathematics. The literature review provided the basis for developing the questionnaire and observation schedule to determine if teachers create opportunities for authentic teaching and learning in their Mathematics classrooms.

The layout of this chapter is as follows:

- Conceptualization of authenticity
- The authentic teacher
- Authentic learning
- Authentic teaching
- The authentic curriculum
- Authentic pedagogy
- Authentic assessment
- Authenticity and Mathematics teaching

#### **2.2 CONCEPTUALISATION OF AUTHENTICITY**

Authenticity is a multifaceted concept that includes at least four parts:

- Authenticity indicates an expression of the genuine self in the community. Cranton (2001:vii) argues that to be able to express the genuine self, people need to know who that self is. In this regard, Mezirow (2000:8), indicates that the development of self-awareness is a transformative process.
- Authenticity implies showing consistency between values and actions (Cranton & Carusetta, 2004b:7).
- Authenticity refers to relating to others in such a way as to encourage their authenticity. This includes developing a relationship with learners that fosters the teacher's own and the learners' ability to be genuine and open (Cranton & Carusetta, 2004b:7).
- Authenticity involves that teachers engage in critical self-reflection about their teaching practice so as to be aware of the assumptions and values that they hold and where these assumptions and values originate (Cranton, 2001:vii; Cranton & Carusetta, 2004b:7).

Cranton (2001:21) describes teaching as a specialized form of communication that has learning as its goal and points out that meaningful communication rests on the premise that teachers speak and act genuinely and honestly, rather than with the intent to manipulate or deceive.

The next section will explore authenticity linked to the role of the teacher.

### **2.3 THE AUTHENTIC TEACHER**

Ray and Anderson (2000:8), on the one hand, indicate that being an authentic teacher includes making sure that your behaviours are congruent with your words, admitting that you do not have all the answers and can make mistakes. Palmer (2000:16) considers this as knowing your own personal limitations. Brookfield (1997:26) takes it further in balancing credibility and authenticity by indicating that teachers should practise what they preach and be sure not to espouse one way of working and behave in a different way in their own teaching. Cranton and Carusetta (2004a:279), on the other hand, state that becoming an authentic teacher appears to be a developmental process that relies on experience, maturity, self-exploration and reflection.

Jarvis (1992:113) suggests that people are authentic when they choose to act with the purpose to “*foster the growth and development of each other’s being*”. Jarvis (1992:113) views this as an experimental and creative act where teachers consciously have the goal of helping another person develop. In other words, teachers and learners learn together through dialogue. In this regard Freire (in Jarvis, 1992:114) advocates that the result of authentic teaching is that “*teachers learn and grow together with their learners*”. Buber’s work (1961) indicates that it is only through relationships with others that authenticity can be fostered.

Jarvis (1992:115-116) also proposes that authenticity is linked with reflective learning. People need to develop as autonomous and rational individuals within their social context. When people’s actions are “*controlled by others and their performance is repetitive and ritualistic*” they are inauthentic (Jarvis, 1992:115-116). Heidegger (1962:24) saw authenticity as involving critical participation, which meant that people question how they are different from the community and live accordingly. They neither do something just because this is the way in which others behave nor believe what others believe without considering whether it is true for them. Authentic people need to know who they are and what they believe in and then act on that. However, this does not mean that people make such decisions in isolation. Authenticity involves knowing and understanding the collective and carefully, critically determining how people are different from and the same as that collective.

Sharp (1995:48) argues for the “*segregation of the individual from the undifferentiated and unconscious herd*”. According to Sharp (1995:48), the segregation of an individual from the herd could be regarded as a first sign that an individual is consciously developing to become an authentic person. Authenticity also refers to being bold, taking risks and recognizing that one cannot always win people over (Cranton & Carusetta, 2004b:8).

As this study focused on the role of the teacher in creating opportunities for authentic teaching and learning, it was important to identify indicators of authenticity that would guide the investigation of the classroom environments. The next section pays attention to these indicators.

### 2.3.1 Indicators of authenticity in teachers

Cranton (2006:6) mentions four specific indicators of authenticity which are **congruence, full disclosure, responsiveness** and **personhood**. Each indicator will be briefly explained.

- **Congruence** refers to congruency between the words and actions of teachers.
- **Full disclosure** implies that the teachers regularly make the criteria, expectations, agendas and assumptions that guide their practice public.
- **Responsiveness** is the dimension of authenticity where teachers focus on demonstrating clearly to learners that they are teaching so as to be most helpful to them. Such clear learner-centeredness, according to Cranton (2006:9), has the following elements. One is the teacher's constant attempt to show that he/she wants to know how and what learners are learning, what inhibitors and enhancers to learning are present in his/her teaching and what concerns learners have about their learning. Another element is the teacher's public discussion with learners of how his knowledge about what learners are learning affects his/her own teaching, including the extent to which some elements of the subject content can be negotiated.
- **Personhood** is the perception that learners have that their teacher is a flesh-and-blood human being with life and identity outside the classroom. In the next session the principles underpinning authentic teaching are explored.

### 2.3.2 Authentic teaching

Linked to teaching, the term authentic implies some notion of reality in terms of its purposes, methods and experiences arising from it. Each of the mentioned aspects will be briefly explored.

#### 2.3.2.1 Teaching purposes

According to Robertson and Fluck (2002), starting from the concept of action learning, it can be argued that authentic teaching would have the purposes of providing the learner with:

- access to existing knowledge
- support for inquiry, and
- increased awareness of personal and shared experience and its relationship to existing knowledge and the possibilities for further inquiry.

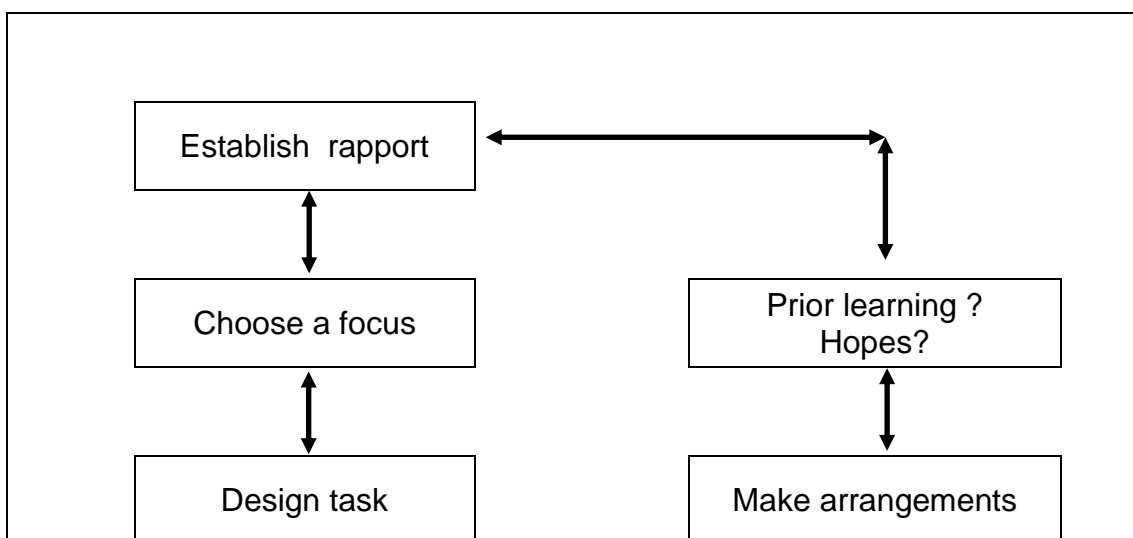
### 2.3.2.2 Teaching methods and experiences

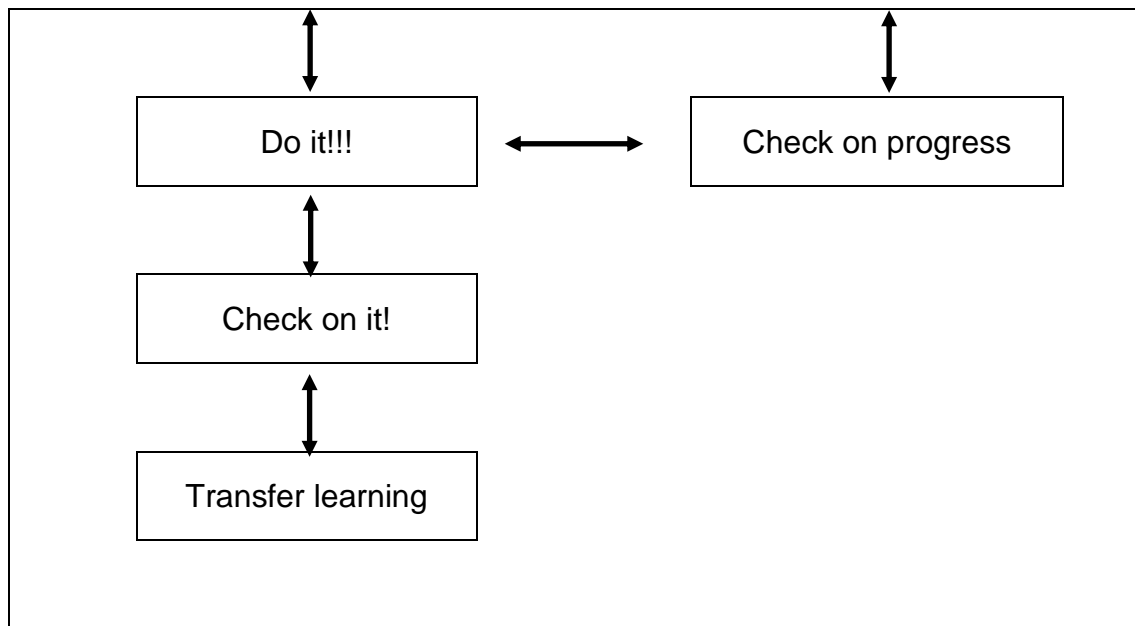
Teaching involves a set of activities and hence may be considered as a process. It draws on:

- Subject knowledge and theoretical knowledge about teaching and learning principles (pedagogy). Cranton (2006:29) argues that the effectiveness of teaching is mediated largely through one's knowledge of the subject matter, related experience and background, skill in being able to render the subject matter accessible and meaningful to learners, ability to listen to learners and capacity to understand and appropriately respond to their struggle to learn.
- Reflective practice (ongoing enquiry into teaching and learning as it is undertaken).
- First-hand and shared experience with colleagues.

This leads to managing teaching as a process, perhaps along the lines of the following model by Robertson and Fluck (2002) in Figure 2.1.

**Figure 2.1: Authentic teaching as a process**





In summary, Figure 2.1 indicates that the teacher has to establish a working relationship between him/herself and learners, decide what is to be learned (checking on what they already know), design learning activities, undertake to monitor and mediate learning while checking on learning achieved and the learning processes used. Finally, opportunities for transfer of learning should be identified.

Other aspects of authentic teaching include:

- Teaching and learning that work within the Zone of Proximal Development (ZPD) of the learner by providing appropriate scaffolding and mediation.
- Working towards the maturity of the learner's conceptual development by giving joint consideration to the abstract concepts being introduced by the teacher or context and the spontaneous concepts achieved by the learner (Robertson & Fluck, 2002).

The researcher argues that regardless of the perspective taken, authentic teaching and learning have the negotiation of meaning at its core. This contrasts to some extent with a transmission and reception approach to teaching. It is believed that if learning is to be authentic (i.e. real, relevant, and meaningful) for learners, then teaching should be grounded in instruction that utilizes a coherent, integrated learning approach that allows learners to have ownership in and share responsibility for their own learning (Robertson & Fluck, 2002).

In the next section authentic learning is explored.

## **2.4 AUTHENTIC LEARNING**

All learning exists on a continuum that ranges from deductive and prescriptive learning at one end to inductive, self-regulated and investigative learning on the other (Renzulli, Gentry & Reis, 2004:74). The essence of inductive higher-order learning is applying relevant knowledge and skills to solving real problems. Such learning involves finding and focusing on a problem; identifying relevant information to solve a problem; categorizing, critically analysing, and synthesizing that information; and effectively communicating the results (Renzulli *et al.*, 2004:74). Authentic learning thus implies that learners are confronted with solving real life problems. Working with real-life problems involves the following criteria. Firstly, real-life problems have a personal frame of reference. In other words, the problem must involve an emotional or internal commitment on the part of those involved, in addition to a cognitive interest. Secondly, no agreed-on solutions or prescribed strategies for solving the problem exist. If they do, the process would more appropriately be classified as a training exercise because its main purpose would be to teach predetermined content or thinking skills. Thirdly, real-life problems motivate people to find solutions that change actions, attitudes or beliefs. Lastly, real-life problems target real audiences (Renzulli *et al.*, 2004:74).

Authentic learning is the vehicle through which everything from basic skills to advanced content and processes come together in the form of learner-developed products and services (Renzulli *et al.*, 2004:74). During authentic learning, the learner's role changes from lesson-learner to firsthand inquirer and the role of the teacher changes from instructor and disseminator of knowledge to coach, resource procurer and mentor. Although products play an important role in creating authentic learning, learners learn principally from the cognitive and motivational processes involved (Renzulli *et al.*, 2004:74). The cognitive processes refer to the ways in which learners receive, process, store and retrieve information, and the motivational processes imply that there should always be ways to instigate and increase the rate of probability of learning taking place (Renzulli *et al.*, 2004:74).

Authentic learning is a laudable goal that should be promoted and pursued vigorously. According to Renzulli *et al.* (2004:74) learners should not only see their work as school-

related, but also related to the real world. They must be able to apply their learning in real-life contexts. Working with real-life problems is a sophisticated process that demands refined skills and a tolerance for ambiguity and complexity (Rick, 1998:4).

According to Hobart (2005:12), authentic learning is a model for high-quality instruction, defined as “*a social practice enabling learners to act knowledgeably and powerfully in the classroom and the world*”, which entails the use of strategies such as: **higher-order thinking, depth of knowledge, connectedness to the world beyond the classroom, substantive conversation, social support for learner achievement, academic challenges, scenario challenges and real-life problems.**

It is clear from the aforementioned characteristics of authentic learning that a constructivist approach to teaching and learning appears to be appropriate for the creation of opportunities to enhance authentic teaching and learning. The researcher will briefly explain this link between the aforementioned characteristics and constructivism, highlighting characteristics of constructivist teaching and learning that augur well with authentic teaching and learning.

#### **2.4.1 Higher-order thinking**

Promoting higher-order thinking during teaching involves learners in manipulating information and ideas by synthesizing, generalizing, explaining or arriving at conclusions that produce new meaning and understanding for them. Higher order thinking is a sub-criterion of construction of knowledge which occurs when information is organized, synthesized, interpreted and evaluated (Stewart & Brendefur, 2005:683). Construction of knowledge suggests that authentic learning experiences, while based on the foundation of prior knowledge, must result in the learner constructing or producing new knowledge.

#### **2.4.2 Depth of knowledge**

Instruction addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understanding. Deep knowledge is a sub-criterion of disciplined inquiry which leads to in-depth understanding (Stewart & Brendefur, 2005:683). Disciplined inquiry consists of three major components: a firm understanding of a prior knowledge base that has been

accumulated in the area of study; an in-depth understanding of the topic being studied and elaborated communication as a proof of competence, involving complex expressions of ideas, justification and explanation.

### **2.4.3 Connectedness to the world beyond the classroom**

Learners make connections between substantive knowledge and either public problems or personal experiences. Connection to the world beyond the classroom is a direct corollary to value beyond school (Stewart & Brendefur, 2005:683). Value beyond school recognizes that most significant intellectual accomplishments are intended either to express one's unique ideas or to influence others. These accomplishments have a value both to the learner and to the intended audience. Authentic learning is driven by essential knowledge that is meaningful to learners. Not every element of a learner's work must be "*real*", but learners need to see connections to the real world on some level. This relevance is best ensured by trying to get learners to work on the 'big' questions, the human commonalities. These questions get to the heart of our culture, history, and future as they relate to the human life cycle; our command of symbols; our understanding of the social web; our connection to science, technology and the natural world; and the interdependence of community and the individual. Likewise, attention to real life skills, such as decision-making and problem-solving, can link learners' work to real-life experience (Rick, 1998:2).

### **2.4.4 Substantive conversation**

Learners engage in extended conversational exchanges with the teacher and/or peers about subject matter in a way that builds an improved and shared understanding of ideas and topics. Substantive conversation is a sub-criterion of disciplined inquiry (Stewart & Brendefur, 2005:683).

### **2.4.5 Social support for learner achievement**

Learners need to experience a learning environment that is characterized by high expectations and respect, and which values the inclusion of all learners in the learning process (Newmann, Secada & Wehlage, 1995:2).

Linked to the above-mentioned characteristics, the term constructivism refers to:

- A view of learning based on the belief that knowledge is constructed by learners individually and socially through an active, mental process of development. Learners are therefore builders and creators of meaning and knowledge (Hein 1991; Gray, 1997:3; Fraser, 2006:6). The constructivist view of learning sharply contrasts with one in which learning is the passive transmission of information from one individual to another, a view in which reception, not construction, is key (Fraser, 2006:6). Two important notions orbit around the simple idea of constructed knowledge. The first is that learners construct new understandings using what they already know. There is no *tabula rasa* on which new knowledge is etched. Rather, learners come to learning situations with knowledge gained from previous experience, and that prior knowledge influences what new or modified knowledge they will construct from new learning experiences (Henry, 2002:67). The second notion is that learning is active rather than passive. Learners confront their understanding in light of what they encounter in the new learning situation. If what learners encounter is inconsistent with their current understanding, their understanding can change to accommodate new experiences. Learners remain active throughout this process: they apply current understandings, note relevant elements in new learning experiences, judge the consistency of prior and emerging knowledge and, based on that judgment, they can modify knowledge.
- A theory according to which all people can know and that knowing is a product of the human's cognition. People create their own conceptions of reality by channeling sensory data towards meditative reflections. Constructivism not only emphasizes the central role of the construer, but maintains that people are partially able to control constructive processes through conscious reflection (Mahoney in Watts & Bentley, 2005:171);
- A philosophy of learning that proposes learners' need to build their own understanding of new ideas (Anon., 2010) and therefore all knowledge is regarded as personal and idiosyncratic (Fox, 2001:24);
- A theory about knowledge and learning; it describes what "*knowing*" is and how one "*comes to know*" (Fosnot, 1996:ix). "A basic assumption is that children learn when they are in control of their learning and know that they are in control" (Green &

Gredler in Epstein, 2002). Constructivism emphasizes the importance of the knowledge, beliefs and skills an individual brings to the experience of learning. It recognizes the construction of new understanding as a combination of prior learning, new information and readiness to learn. Individuals make choices about what new ideas to accept and how to fit these ideas into their established views of the world (Brooks & Brooks, 1995:21).

- An approach that underpins meaningful learning which is based on the following four principles:
  - meaningful learning depends on what we already know, that is, new ideas occur as people adapt and change their old ideas;
  - meaningful learning involves inventing ideas, rather than mechanically accumulating facts;
  - meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas which conflict with our old ideas; and
  - meaningful learning consists of learner-centered active instruction. In this type of instruction where the teacher acts as a facilitator, learners are provided with experiences that allow them to hypothesize, predict, manipulate objects, pose questions, research, investigate, imagine and invent (Fosnot, 1989:9; Fraser, 2006:7,8).
- Knowledge is invented, not discovered. Shared meanings develop through negotiation in the learning environment, leading to the development of common or shared knowledge. All knowledge is socially constructed, and social interaction within the learning environment is an essential part of this experience. Learning takes place within some socio-cultural setting, a community of practice in which we can think of social actions as well as social interactions (Fox, 2001:24).
- Learning is essentially a process of making sense of the world, and effective learning requires meaningful, open-ended, challenging problems for the learner to solve.

In a constructivist classroom the focus is on how individual learners accommodate information into existing schemata of information. According to Henry (2002:67), learners should be challenged to re-organize their cognitive world to account for new experiences. They need to embrace problems as their own, use prior knowledge as the starting point for solving problems, accommodate new information and construct tentative solutions by integrating old and new knowledge together. Learning should be anchored around big ideas that can be generalized across experiences (Henry, 2002:67). Instead of focusing on discreet pieces of data and collection of facts, learners should conceptualize in a more global sense. Facts and information should not merely be memorized and reproduced, but rather used as tools to form generalizations and understandings with greater meaning (Henry, 2002:67).

Constructivist classrooms allow learners to pursue open-ended investigations and generate several possible solutions or explanations to a problem. Learners actively question and interpret materials to develop conceptual understandings. In such a setting, learning is deeper, more comprehensive and longer lasting. In such an environment, the teacher is both a facilitator of enquiry and a transmitter of knowledge (Henry, 2002:67).

Constructivism has important implications for teaching. In the first place, teaching cannot only be viewed as the transmission of knowledge from enlightened to unenlightened. Constructivist teachers do not take the role of the “*sage on the stage*”. Rather, teachers act as “*guides on the side*” who provide learners with opportunities to test the adequacy of their current understandings (Henry, 2002:67).

In the second place, Henry (2002:67) argues that constructivist learning is based on prior knowledge (*cf.* 2.4.2). Teachers should provide learning environments that exploit inconsistencies between learners’ current understandings and new experiences. This challenges teachers and they cannot assume that all learners understand something in the same way. Furthermore, learners may need different experiences to advance to different levels of understanding (Henry, 2002:67).

Thirdly, if learners must apply their current understandings to new situations in order to build new knowledge, then teachers must engage learners in learning, bringing learners’ current understandings to the forefront. Teachers can ensure that learning experiences

incorporate problems that are important to learners, not those that are primarily important to teachers and the educational system. Teachers can also encourage group interaction, where the interplay among respondents helps individual learners become explicit about their own understanding by comparing it to that of their peers (Henry, 2002:67).

Fourthly, if new knowledge is actively built, then time is needed to build it. Ample time facilitates learners' reflection about new experiences, how those experiences line up against current understandings and how a different understanding might provide learners with an improved (not "correct") view of the world (Henry, 2002:67).

Both substantive conversation (*cf.* 2.4.4) and social support for learner achievement (*cf.* 2.4.5) which were highlighted as characteristics of authentic learning, reflect the tenets of social constructivism. Social constructivism argues that learners can, with help from adults or children who are more advanced, grasp concepts and ideas that they cannot understand on their own. Unlike cognitive constructivism, teachers in social constructivism do not just stand by and watch children explore and discover. The teacher may guide learners as they approach problems, may encourage them to work in groups to think about issues and questions, and support them with encouragement and advice (Fraser, 2006:6). Social constructivism is based on specific assumptions about reality, knowledge and learning.

Social constructivists believe that **reality** is constructed through human activity. Members of a society together invent the properties of the world (Kukla, 2000). For the social constructivist, reality cannot be discovered: it does not exist prior to its social invention. To social constructivists, **knowledge** is a human product and is socially and culturally constructed (Gredler, 1997:59; Prawat & Floden, 1994:37-48). Individuals create meaning through their interactions with one another and with the environment they live in. Social constructivists view **learning** as a social process. It does not take place only within an individual, nor is it a passive development of behaviours that are shaped by external forces. Meaningful learning occurs when individuals are engaged in social activities (Fraser, 2006:11).

Social constructivists see as crucial both the context in which learning occurs and the social contexts that learners bring to their learning environment. There are four general

perspectives that inform how we could facilitate the learning within a framework of social constructivism (Gredler, 1997:59):

- **Cognitive tools perspective:** This perspective focuses on the learning of cognitive skills and strategies (*cf.* 2.4.1). Learners engage in those social learning activities that involve hands-on project-based methods and the utilization of discipline-based cognitive tools (Prawat & Floden, 1994:37-48; Gredler, 1997:59; Vakalisa, Van Niekerk & Gawe, 2007:170-171) in order to produce a product and, as a group, impose meaning on it through the social learning process.
- **Idea-based social constructivism:** This sets education's priority on important concepts or ideas in the various disciplines (e.g. part-whole relations in Mathematics, photosynthesis in science and points of view in literature (Prawat & Floden, 1994:37-48; Gredler, 1997:59). These "big ideas" expand learner vision and become important foundations for learners' thinking and construction of social meaning (Gredler, 1997:59).
- **Pragmatic or emergent approach:** Social constructivists assert that the implementation of social constructivism in class should be emergent as the need arises (Gredler, 1997:59). Its proponents hold that knowledge, meaning and understanding of the world can be addressed in the classroom from both the view of the individual learner as well as the collective view of the entire class (Cobb, 1995:25-27; Gredler, 1997:59; Arends, 2009:12).
- **Transactional or situated cognitive perspectives:** This perspective focuses on the relationship between the people and their environment. Humans are a part of the constructed environment (including social relationships); the environment is in turn one of the characteristics that constitutes the individual (Gredler, 1997:59). When a mind operates, its owner is interacting with the environment. Therefore, if the environment and social relationships among group members change, the tasks of each individual also change (Gredler, 1997:59). Learning should thus not take place in isolation from the environment. In authentic learning situations, people work together and are not characterized by the artificial boundaries of what some call the 'graveyard model of teaching' (everyone in rows and dead) (Rick, 1998:2). Learners move about, talk to one another and are active both physically and mentally. They

find resources to help solve problems from fellow learners, books or the internet. The focus is not only on what you have stored inside your head, but on what you can actually do to solve a problem using the resources around you (Rick, 1998:2).

#### **2.4.6 Authentic learning and academic challenges**

Learning activities should provide an entry point into authentic, problem-based learning. An academic challenge is provided to learners if their work is structured as a problem arising directly from an area of study (Rick, 1998:3). A problem is used primarily to promote greater understanding of selected subject matter. The academic challenge is crafted by transforming existing curricular material into a problem format. They serve as a useful access point for developing a capacity for actively constructing learning, working collaboratively, targeting specific outcomes, focusing on standards of quality and grappling with essential questions (Rick, 1998:3).

#### **2.4.7 Authentic learning and scenario challenges**

Scenario challenges cast learners in real-life roles and ask them to perform these roles in the context of a reality-based or fictional scenario. The scenario challenge simulates many of the elements of the real world as a way of working with existing curricular material. Learners begin to see themselves in real-life roles as they develop the knowledge and skills needed for success in school and beyond (Rick, 1998:3).

#### **2.4.8 Authentic learning and real-life problems**

Authentic learning demands that learners actively solve problems. Life involves an ongoing series of problems to solve, decisions to make, concepts to understand, and products to produce (Rick, 1998:3). Whether it is a relatively simple matter of deciding what to eat for breakfast or a more complex one such as figuring out how to reduce pollution in one's community, in life we make decisions and do things that have concrete results. Real-life problems are actual problems that need real solutions by real people or organizations. They involve learners directly and deeply in the exploration of an area of study (Rule & Hallagan, 2007:4). The solutions have the potential for actual implementation in the classroom, school, community, at regional, national or global level. Through real-life problems, learners move outside the classroom, take action on issues and have a tangible impact in their communities. These assignments can be

powerful learning experiences, but pulling off more than one or two of them a year seems to be beyond the resources (energy, time, and money) of most teachers and schools (Rule & Hallagan, 2007:4).

Moreover, for learners to succeed with real-life problems, it helps if they have experienced working in collaborative problem-solving teams (Gradgenett & Harris, 2007:2). The skills and attitudes of collaborative problem-solving are best developed through coordinated work on problems of increasing complexity and uncertainty (such as academic and scenario challenges).

According to Gradgenett and Harris (2007:2) and Rick (1998:3), the framework that guides the creation of authentic learning in all settings, is the experiential learning cycle (ELC) which offers an approach to make learning activities more authentic and real-life problems more focused. At the heart of the ELC are what we call challenges or problems to solve, which are driven by desired outcomes, namely what we want learners to know, do and be like (knowledge, skills and attitudes) (Rick, 1998:3). To help make challenges accessible to teachers and learners, they can be categorized on three levels of generally increasing authenticity, complexity, uncertainty and learner self-direction. The ELC includes both learner and teacher dimensions. The learner phases of the cycle are engagement, exhibition and reflection (Rick, 1998:3). First, learners are engaged in a problem that has been crafted by the teacher to target specific knowledge, skills and attitudes. This challenge, as do many real-life problems, usually requires some concrete product as evidence of learner learning. During the engagement phase, learners and teachers spend time articulating standards, based on real-world models, for the quality of the product. In the course of engagement, and in the exhibition of this product, learners demonstrate their learning. After completion and exhibition of their products comes the reflection phase, in which learners examine their work and reflect on what they learned (reinforcing and constructing knowledge and considering their personal and interpersonal behaviours). Learners may then join the teacher in assessment of their work based on their pre-established standards of quality (Rick, 1998:3).

The teacher-led phases of the ELC are design, coaching and feedback (Rick, 1998:4). Once learners have begun work on a problem that has been carefully designed by the

teacher to target specific knowledge, skills and attitudes, the teacher assumes the role of coach, helping learners develop their skills and knowledge, shape their strategies, and find appropriate resources. Like a coach, the teacher remains on the sidelines at times, allowing learners to own their successes and failures. Here, the learners are truly the workers, and the quality of their work reflects their efforts. In the feedback phase, teachers create structures within which learners can reflect on and assess their products, processes and level of understanding (Rick, 1998:4).

Experiential learning also requires teachers to utilize a variety of teaching methods and teaching strategies during teaching, as experiential learning refers to learning that takes place where evidence of achieving learning outcomes should have required learners to experience, observe, reflect, think and act (Grosser, 2002:11). Furthermore, authentic learning allows learners to explore, discover, discuss and meaningfully construct concepts and relationships in contexts that involve real-world problems and projects that are relevant and interesting to the learner (Grandgenett & Harris, 2007:2). It is therefore important that teachers utilize a variety of teaching methods and strategies in order to allow learners to explore, discover, discuss and construct. In the context of the study the researcher refers to the distinction made by Eggen & Kauchak (2010:419), Kramer (2006:102-106) and Borich (2004:22) who highlight the importance of balancing the application of direct, indirect, independent and interactive teaching methods and their related strategies during instruction.

During **direct instruction**, the teacher takes a central role and is the source of learning. Learners are passive receivers of information, and the most frequently utilized strategies in this approach are lectures, presentations, demonstrations and guided worksheets with corrective feedback (Grosser, 2002:23-24).

The use of **indirect instruction** links well with the use of the learner-centered style of teaching, and has a high potential for building higher-order thinking skills which is a strong focus of authentic teaching and learning. Learners are actively involved in the teaching and learning process through personal inquiry by *inter alia* utilizing teaching strategies such as field trips, case studies and role plays, and involving learners in design-and-make activities (Kramer, 2006:102).

The utilization of **independent instruction** implies a stronger focus on the learner who undertakes a learning task by him/herself, with the teacher only fulfilling a directing and helping role (Kramer, 2006:104). Independent teaching *inter alia* refers to the use of teaching strategies such as research projects, one-on-one debates, assignments and crossword puzzles.

**Interactive** teaching methods and strategies focus on individualized learning where teachers and learners cooperate in the learning adventure. Although teachers and learners cooperate, interdependence is balanced with individual accountability for certain learning tasks. The focus is *inter alia* on processes and skills, that are important in the context of authentic teaching and learning, namely the development of thinking processes and logical reasoning (Kramer, 2006:105-106). According to Gawe (2007:221-223), interactive instruction provides opportunities for learners to interact with their peers, experts and their teachers in such a manner as to improve their social skills as well as their abilities to assess information and structure an effective response to the information. The interaction is often highly motivating for nurturing the learners' creative thinking abilities. Interactive teaching is characterized by the utilization of strategies such as Jigsaw, Group Investigation and Learning Together, and techniques such as Round Table, Round Robin, Fishbowls and Brainstorming (Gawe, 2007:221-223).

In conclusion, the researcher summarizes the link between authentic learning and constructivism as follows:

- Learners learn with others and in groups
- Active involvement of learners during learning
- Learners involved in the construction of knowledge
- The application of knowledge to real-life problems
- Learning being useful and meaningful to learners
- Learner participation in deciding what should be learned and how learning should take place
- Constructing knowledge through social negotiation and interaction

- Learners are at the centre of the teaching and learning act
- Teaching promotes higher-order thinking.

In the next section the authentic curriculum is explored.

## **2.5 THE AUTHENTIC CURRICULUM**

In authentic teaching and learning, knowledge, skills and attitudes learned and employed in one context are carried over to another (Rick, 1998:2). The curriculum looks less like a compilation of discrete building blocks and more like a continuous ascending spiral in which each experience builds on previous ones, as learners increase their understanding and improve their skills. Authentic learning situations simultaneously involve your knowledge, skills, and attitudes. In real-life situations, you use your organizational skills to manage resources to make decisions about how to solve problems, using the knowledge you possess to produce a result that meets your internalized sense of quality (Rick, 1998:2). Knowledge, skills and attitudes are developed in the context of actual work.

An authentic coherent, integrated curriculum is one that reflects the real world, is interactive and involves the learner's entire self, thoughts, feelings, senses and intuition (Kraft & Billig, 1997:6; Jacobs, 2007:35-83). Through integrated teaching, learning and assessment that organize information around conceptual themes, teachers can provide learning experiences that unify knowledge and promote a greater understanding as opposed to learners examining the subject separately. This kind of teaching enables complex thinking skills in learners which is a necessity as they have to grapple with real issues and problems that transcend the boundaries of disciplines. By bringing relevance to learners' lives, a coherent, integrated curriculum has an added benefit. Research shows that learners attribute the lack of relevance during teaching as one of their main reasons for dropping out of school (Kraft & Billig, 1997:6)

## **2.6 AUTHENTIC PEDAGOGY**

According to Newmann *et al.* (1995:13), teachers communicate what is important to learn through two main activities, namely tests or other tasks that they use to assess learner mastery and the instruction they conduct to help learners prepare for the

assessment. Together, these comprise pedagogy. Newmann *et al.* (in Kraft & Billig, 1997:5) four year national study on restructured schools concludes that instruction must be focused on authentic pedagogy if learners are to achieve high standards of intellectual quality. These standards, according to Kraft and Billig (1997:6), include:

- Learners constructing meaning and producing knowledge (organizing, synthesizing, interpreting or evaluating complex information; considering alternative solutions, strategies or points of view)
- Learners using disciplined inquiry to construct meaning (showing understanding and use of ideas, theories or perspectives central to an academic discipline; using methods of inquiry, research or communication characteristic to an academic discipline)
- Learners aiming their work towards production of discourse, products, and performances that have value or meaning beyond success in school (elaborating on understanding or conclusions through extended writing or other demonstrations or products; addressing a concept, problem or issue similar to one that they may encounter outside the classroom; communicating knowledge, presenting thinking or taking some action beyond the classroom and school)

While the evidence reveals that authentic teaching can help to boost learner achievement for all learners, Kraft and Billig (1997:6) also points out that certain conditions or factors need to be in place in order for this to occur. It cannot be assumed that preoccupation with the tools of restructuring will automatically result in high intellectual quality learner learning. Newmann *et al.* (1995:29) concur that the challenge is not just to adopt innovation, but to learn how to use new structures to enhance high intellectual quality. Without aiming towards the end, there is little reason to implement innovative structures. Thus, a school's success in educating learners depends on the commitment of individuals within the staff. When schools are unable to coordinate teachers' diverse aims for learners into a curricular mission focused on high quality learner learning, when teachers have few opportunities to work together to devise approaches suited to the school's learner body or when schools pursue multiple innovations without sustained, long-term consistency, it is difficult for even the most gifted teachers to make a positive difference for learners (Kraft & Billig, 1997:8).

Therefore, in order for learners to be engaged in meaningful learning, opportunities must be present for staff to engage likewise in meaningful and collective learning (Kraft & Billig, 1997:8). Schools cannot be re-created as collaborative learning communities without sustained professional development and dialogue. This entails that schools reach clarity and consensus about central goals for learner learning and incorporate sufficient flexibility to encourage debate, discussion and experimentation within the framework. Thus, schools need to become learning communities that foster teachers' intellectual growth and professional development as well (Kraft & Billig, 1997:9).

In the following section, the principles of authentic assessment are explored.

## **2.7 AUTHENTIC ASSESSMENT**

Authentic assessments are essentially those that embed assessment in real-world contexts (Custer, 2000:3). Mueller (2005:14-18) and Luongo-Orlando (2003:7) describe authentic assessment as tasks and procedures in which learners are engaged in applying essential skills and knowledge to solve 'real world' problems, giving the tasks a sense of authenticity. Authentic assessment measures are engaging and worthy problems or questions of importance, in which learners must use knowledge to fashion performances effectively and creatively. These tasks are either replicas of or analogous to the kinds of problems and challenges faced by adult citizens and consumers or professionals in the field (Mueller, 2005:15). Such assessment activities encourage risk taking, allow for Mathematical communication and provide the opportunity to demonstrate the application of knowledge in unfamiliar settings. When structuring assessment activities or tasks, the educators needs to incorporate a variety of assessment strategies such as: examinations, projects, tests, research projects, assignments, surveys, debates, role play, drama, interviews, panel discussions, demonstrations.

The main purpose of the assessment processes and practices mentioned above is to promote cognitive development and growth through the achievement of outcomes. Thus the main role of the educator is to expose learners to all these processes and practices by selecting a variety of assessment strategies through which the learner can learn and develop all the necessary knowledge and skills which will, in turn, enable him/her to demonstrate his/her ability to convert knowledge into deeper meta-cognitive

levels, and progress from knowledge learning targets to reasoning targets of demonstrating skills and presenting products (Kotze, 2004:48).

In authentic learning situations, learners publicly exhibit their learning, and there are often real-life standards of quality (Rick, 1998:2). Authentic problems don't generate scores in a test. There is usually some authentic benchmark instead to which learners are accountable. For example, if learners make a proposal to the town council, the council responds and perhaps approves it. If learners are making a product such as a poster, there are models of excellence against which the product can be judged. Exhibiting one's work publicly places it up against these real-world standards of quality

Other terms that are used for authentic assessment include alternative forms of assessment in addition to the use of tests and exams, namely performance-based or Outcomes-Based assessment (Suurtamm, 2004:499). Performance-based assessment engages learners in real-world tasks and scenario-based problems (*cf.* 2.4.7). Tasks are largely open-ended and can be answered using multiple approaches. Outcomes-Based assessment looks into processes and products used. The process is assessed in order to assist and encourage learners to follow a pathway of learning and the product is assessed after a process of learning has happened. Learners are assessed according to assessment criteria rather than against the norm in the class (Suurtamm, 2004:499).

Authentic assessment places a greater emphasis on problem-solving, critical thinking, comprehension, reasoning and metacognition or self-reflection skills than on traditional assessment techniques which involve tests and exams. The formats for learner work recognize learners' multiple intelligences, different learning styles and varying developmental levels (Luongo-Orlando, 2003:7).

A number of criteria have been used to define and describe authentic assessment. Among these are the following (Guilkers, Bastiaens & Kirschner, 2004:67-76):

- engaging and worthy problems or questions of importance to learners;
- tasks that require the learner to produce a high-quality product and/or performance;
- transparent or demystified assessment criteria or standards;

- response-contingent challenges in which the effect of both process and product/performance determines the quality of the results;
- emphasis on 'higher-level' thinking and complex leaning;
- evaluation of the essentials of performance against well-articulated performance standards often expressed as rubrics; and
- assessment so firmly embedded in the curriculum that they are practically indistinguishable from instruction.

To the researcher it appears that authentic assessment has strong links with an assessment for learning approach and she motivates the argument as follows.

Assessment for learning focuses on the intellectual development of the learners and other attributes such as motivation, productive and collaborative skills, values, attitudes, self-confidence, self-esteem and emotions. The main purpose of this new assessment approach is to nurture and promote the development and functioning of the learners' being (Geysler, 2001; Chappius & Stiggins, 2002:40; Black, Harrison, Lee, Marshall & Wiliam, 2004:18).

Assessment for learning involves meaningful learning which is constructive, reflective and self-regulated, and promotes the construction of meaning, reflection and self-monitoring (Herman, 1992:75). Reflection, according to Ross (in Davies & Waverly, 2005:2), refers to thinking about process and product. Important is not what the learners know and how they develop knowledge, but how they construct knowledge and the meaningful and challenging tasks that teachers present to learners in the classroom. The teacher as the facilitator of learning and assessment needs to inform the learners about the intended outcomes at the beginning of the teaching and learning process (Stiggins, 2002:761; Davies & Waverly, 2005:2).

When deciding on methods for assessing the learners, the teacher may utilize self and peer assessment. Self-assessment refers to the learner assessing his own tasks (Stiggins, 2002:761-762) through which he/she learns to think critically about his/her own work, monitor their own progress and evaluate the outcome of their own efforts (Black *et al.*, 2004:9). This type of assessment provides learners with the opportunity to

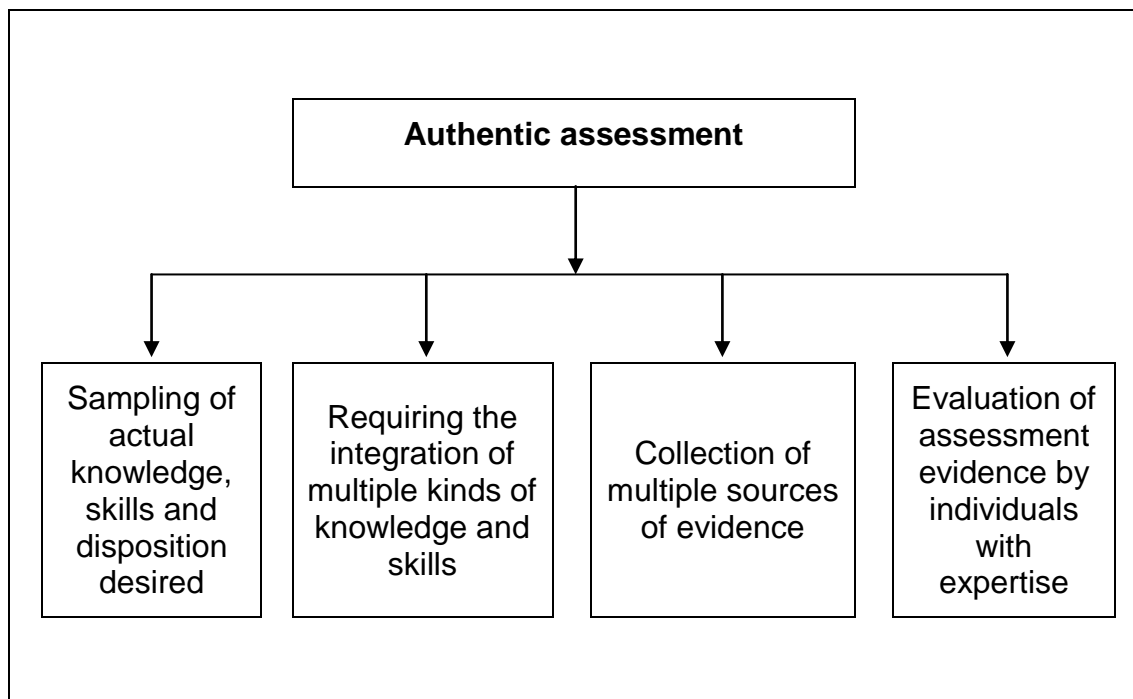
reason, inquire, formulate problems, solve problems, analyse, make decisions and ultimately apply skills in new situations requiring the same skills (Black *et al.*, 2004:19).

Learners should also get the opportunity to assess one another in the classroom in order to learn how to accept criticism of their work from one another (Black *et al.*, 2004:139-148). In addition to this, Black *et al.* (2004:18) assert that peer assessment can enhance motivation for learning, self-esteem and self-confidence (Black *et al.*, 2004:18).

To design an authentic assessment activity, teachers must first determine the actual performances that they want learners to be good at and then they must decide how they can frame learning experiences in a meaningful context that provides the connections between real-world experiences and school-based ideas (Custer, 2000:4).

Figure 2.2 highlights a framework for defining authentic assessment by Darling-Hammond and Snyder (2005:526).

**Figure 2.2: A framework for defining authentic assessment**



The four aspects of authentic assessment of teaching for measuring teaching and enhancing the ability of teachers to teach well, are outlined below. Authentic assessment captures the constructive nature of teaching and learning. Learners need

to construct their meaning of the world, using information they have gathered and were taught, as well as their own experiences with the world. Learners must be given opportunity to engage in the construction of meaning (Mueller, 2005:16).

### **2.7.1 Sampling of actual knowledge, skills and disposition desired**

According to Darling-Hammond and Snyder (2005:527), assessment tasks include actual examples of the learners' work. Such assessment seeks to varying degrees, to deal with the problem of enactment; that is the fact that talking or writing about teaching, cannot fully predict a person's capacity to succeed in the complex realities of actual teaching in the classroom.

### **2.7.2 Requiring the integration of multiple kinds of knowledge and skills**

Assessment that mirrors teaching by seeking to integrate areas of knowledge used in combination can help forge connections between areas of knowledge while better representing the tasks teachers must actually perform (Darling- Hammond & Snyder, 2005:527).

### **2.7.3 Collection of multiple success of evidence**

Assessment should provide candidates with opportunities to show their abilities in different settings, with different learners, and with different learning content (Darling-Hammond & Snyder, 2005:528).

### **2.7.4 Evaluation of assessment evidence by individuals with expertise**

Involving two people or more people in assessment might draw entirely different conclusions for what constitutes a good or competent learner performance (Darling-Hammond & Snyder, 2005:528).

## **2.8 AUTHENTICITY AND MATHEMATICS TEACHING**

The strong focus on providing opportunities for authenticity during the teaching of Mathematics is highlighted by the Department of Education (2003:24-25). Effective teaching and the attainment of learning outcomes in Mathematics rely on understanding Mathematics and understanding of what learners know and what they need to know

(Department of Education, 2003:24). This statement highlights the importance of depth of knowledge (*cf.* 2.4.2), which is a principle of authentic teaching and learning. The teacher of Mathematics has to apply a wide repertoire of teaching strategies such as problem-posing, problem-solving, observation, modeling, reading, group work and drill and practice (Department of Education, 2003:24). This augurs well with the idea of utilizing a variety of teaching methods and teaching strategies during teaching in order to enhance authenticity during teaching and learning (*cf.* 2.4.6; 2.4.8). Regarding the use of assessment strategies, the Department of Education (2003:17) suggests the use of a wide range of assessment strategies to measure learner performance such as tests, performance-based assessment, interviews, questionnaires, structured questions, assignments, case studies, practical exercises, projects, role-plays, simulations, oral questions, observations and self-report assessment. This suggestion is in line with the principles of authentic assessment, namely the use of performance-based assessment and employing a variety of assessment strategies to assess knowledge, skills, values and attitudes (*cf.* 2.7).

Learners should engage in worthwhile and challenging tasks, and solve problems related to their lives or problems of a purely mathematical nature (Department of Education, 2003:24). Similarly, authentic teaching and learning focuses on getting learners involved in solving real-life problems (*cf.* 2.4.8). Learners in the Mathematics classroom must have the opportunity to negotiate meaning and discuss their understanding of concept with each other and their teacher (Department of Education, 2003:24). This links well with the notion of **substantive conversation** that characterizes authentic teaching and learning. Learners engage in conversations with the teacher and/or peers about subject matter in order to build an improved and shared understanding of ideas and topics (*cf.* 2.4.4). In line with the principles of authentic assessment, assessment in Mathematics must be transparent and assessment strategies need to be varied (*cf.* 2.7).

In addition to the general issues raised above, the focus of teaching, learning and assessment per Learning Outcome in the Intermediate Phase indicate numerous opportunities to enhance authentic teaching and learning. A few examples will be highlighted below:

- **Learning Outcome 1 (Numbers, operations and relationships):** Regarding fraction work in the Intermediate Phase learners should have constant and easy access to objects such as counters, fraction cards and fraction walls (Department of Education, 2003:35). This links well with the notion of active involvement during teaching and learning (*cf.* 2.4.7). The development of higher-order thinking is promoted among learners (*cf.* 2.4.1) as they are expected to perform mental calculations such as estimation, judging the reasonableness of the selection of operations and the quality of a solution.
- **Learning Outcome 2 (Patterns, functions and algebra):** The authentic teaching and learning principle of conversation during teaching and learning (*cf.* 2.4.4) and social interaction (*cf.* 2.4.5) can be nurtured during the development of the skills to be able to recognize different representations of a situation being equivalent (Department of Education, 2003:39). Learners need to appreciate that they as learners can have different verbal descriptions to the same pattern, which according to the researcher can be achieved when learners are given the opportunity to talk to one another and interact with one another about their descriptions of patterns.
- **Learning Outcome 3 (Geometry):** Properties of shapes as well as the classification of shapes should be established through active investigation through construction and measurement. Learners should physically place shapes over another in order to compare them (Department of Education, 2003:40). This corresponds well with the authentic teaching and learning principle of active involvement during teaching and learning (*cf.* 2.4.7).
- **Learning Outcome 4 (Measurement):** Measurement of shapes, objects and time should be dealt with in a practical manner, which also supports the authentic teaching and learning principle of active involvement (*cf.* 2.4.7) and learner participation (*cf.* 2.4.2) during teaching and learning (Department of Education, 2003:42).
- **Learning Outcome 5 (Data handling):** During data handling learners can be provided with opportunities to gather data related to real-life phenomena, which supports the authentic teaching and learning principle of involving learners in events related to their lives, such as measurement and time (*cf.* 2.4.7). Furthermore,

dealing with this outcome can provide opportunities for learners to interact and share their findings and interpretations of data. This can promote the authentic teaching and learning principle of conversation and social involvement during teaching and learning (*cf.* 2.4.4; 2.4.5) (Department of Education, 2003:43).

## **2.9 CHAPTER SUMMARY**

In this chapter, the concept authenticity was explored in order to assist the researcher to construct a questionnaire and an observation schedule to determine whether the criteria of authentic teaching, learning and assessment translate into the instructional practices of Intermediate Phase Mathematics teachers. The literature revealed that authenticity on the part of the teacher refers to self-awareness, making public expectations that guide instructional practice, relationships with learners and critical self-reflection on teaching and learning practices (*cf.* 2.3).

Authenticity in general refers to self-awareness, a consistency between values and actions, building relationships with learners and involvement in self-reflective practice (*cf.* 2.2). An authentic teacher (*cf.* 2.3) is concerned with the growth and development of his learners, focuses on learner-centered teaching, allows learners to be actively involved during teaching and learning, and makes public the expectations that he/she has for teaching, learning and assessment.

This chapter also explored authentic learning (*cf.* 2.4). Authentic learning involves learners in solving real-life problems and the application of knowledge in real-life contexts (*cf.* 2.4). Furthermore, authentic learning aims at developing learners' higher-order thinking skills (*cf.* 2.4.1), increases learners' their depth of knowledge by building on learners' pre-knowledge (*cf.* 2.4.2), transcends teaching to the world beyond the classroom (*cf.* 2.4.3), involves learners in conversation with their peers during teaching (*cf.* 2.4.4) and acknowledges the role of social support in learner achievement (*cf.* 2.4.5). In addition to this, authentic learning also creates opportunities for learners to play real-life roles (*cf.* 2.4.7), to engage in experiential learning through the utilization of a variety of teaching methods (*cf.* 2.4.8) and to focus on the development of knowledge, skills, values and attitudes (*cf.* 2.4.8).

For a curriculum to be regarded as authentic it has to reflect relevance to the real world, focus on nurturing complex thinking skills and integrate teaching, learning and assessment (*cf.* 2.5). Learners have to take responsibility for the construction of knowledge through independent inquiry in order to produce work of quality (*cf.* 2.6).

The literature review revealed that authentic assessment augurs well with the principles of assessment for learning (*cf.* 2.7). Authentic assessment emphasizes the collection of multiple sources of evidence to make judgments about the performance of learners, the application of higher-order thinking skills during assessment and the use of performance-based assessment tasks in which learners can demonstrate the application of knowledge (*cf.* 2.7).

Finally, authenticity in the context of Mathematics teaching was explored. According to the Department of Education (2003:24) the teaching, learning and assessment of Mathematics should focus on depth of knowledge, the utilization of a variety of teaching and assessment strategies, problem-based learning and the negotiation of meaning which are all principles of authentic teaching and learning (*cf.* 2.8).

In the next chapter, the empirical research design that was used in the context of the study is described.

# **CHAPTER THREE**

## **EMPIRICAL RESEARCH DESIGN**

### **3.1 INTRODUCTION**

The preceding chapter provided an important background to the investigation contained in this research. It provided a literature review of authentic teaching and learning which informed the development of a questionnaire and observation schedule to determine the extent to which opportunities for authentic teaching and learning are provided in the Mathematics classroom.

This chapter will elaborate on the empirical research that was conducted to collect data in order to achieve the aim and objectives of the study.

The following aspects will be addressed in this chapter:

- Aim and objectives of the research
- Research paradigm
- Research design
- Research strategy
- Data collection instruments
- Population and sample
- Pilot study
- Data analysis

### **3.2 AIM AND OBJECTIVES OF THE RESEARCH**

The overall aim of the empirical research was to determine to what extent teachers create opportunities for authentic teaching and learning in the Mathematics classroom.

The overall aim was operationalized by:

- determining what authentic teaching and learning entail;
- establishing teachers' understanding of what authentic teaching and learning in the Mathematics classroom entail;
- examining learners' perceptions regarding the application of authentic teaching and learning in the Mathematics classroom;
- investigating how teachers enhance the authenticity of teaching and learning in the Mathematics classroom;
- determining whether there is a difference between learner and teacher responses regarding the extent to which opportunities for authentic teaching and learning are created in the Mathematics classroom; and
- making recommendations on how to improve the authenticity of teaching and learning in the Mathematics classroom.

### **3.3 RESEARCH METHOD**

Before the research was conducted, it was necessary to identify an apposite research framework or paradigm that would guide the execution of the research.

#### **3.3.1 Research paradigm**

According to Cohen *et al.* (in Maree & Van der Westhuizen, 2007:31), research is about understanding the world, and your understanding is informed by how you see the world, what you view understanding to be and what you see as the purpose of understanding. This implies that a researcher should:

- determine whether reality will be understood from an external, objective (realistic) view, or through the words created by individuals (nominalist view) (Cohen *et al.* in Maree & Van der Westhuizen, 2007:31);
- determine whether knowledge can be viewed as objective (positivist stance) or interpretive (anti-positivist stance); and

- adopt a stance regarding human nature, that is: whether humans respond mechanically to their environment, whether they initiate their own actions or whether they fall somewhere between the two mentioned extremes.

The decisions the researcher made regarding the above, impacted on the choice of research design, research strategy, data collection instruments and sampling techniques. The researcher's stance regarding the above directed the study towards an external objective view, which located the study within a positivistic paradigm.

A positivistic framework acquires quantitative data by means of experiments or surveys (Maree & Van der Westhuizen, 2007:33). This paradigm suggests that scientific knowledge can be described in a systematic and objective way. With this study, the perceptions of teachers and learners as well as the characteristics of the teaching and learning in Intermediate Phase Mathematics classrooms were quantitatively and objectively determined by means of a questionnaire and an observation schedule. The data collected were reported as frequencies, means and percentages. In interpreting the observation data, the frequencies or incidences of observed situations were noted (Cohen *et al.*, 2007:400). The positivistic framework guided the researcher in adopting a quantitative research design for the study.

### **3.4 RESEARCH DESIGN**

#### **3.4.1 The quantitative research design**

As the researcher decided to be an external observer, whose aim was to establish and form relationships and develop generalizations that contribute to theory based on data that was obtained through objective measures that existed independently from the feelings and opinions of individuals, a quantitative research method was selected (Leedy & Ormrod, 2005:95; Welman, Kruger & Mitchell, 2005:6). Quantitative research is a process that is systematic and objective in its ways of using numerical data from only a selected subgroup of a universe (population) to generalize the findings of the universe (population) that is being studied (Maree & Pietersen, 2007a:145).

The dominant methodology for this type of research is to establish, explain and confirm a given situation in the classroom by collecting numerical data on observable behaviour

from a population or from one or more large samples that represent the population in a form that is easily converted to numerical indices (Leedy & Ormrod, 2005:96).

For the purpose of this research, a quantitative research design was chosen as this study entailed a first investigation and the researcher wanted to provide a summary of an existing phenomenon (authentic teaching and learning) and assess the nature of existing conditions. No intervention took place (McMillan & Schumacher, 2006:24, 215).

### **3.5 RESEARCH STRATEGY**

A research strategy refers to the plan and structure of the investigation used to obtain evidence to answer research questions. The strategy describes the procedures for conducting the study, including when, from whom, and under what conditions the data will be obtained. A research strategy indicates how the research is set up; what happens to the subjects and what methods of data collection are used (McMillan & Schumacher, 1993:31; Babbie, 2001:112).

This research made use of a non-experimental, descriptive survey and observation strategy. Non-experimental strategies describe something that has occurred or examine relationships between things without suggesting direct cause-and-effect relationships. This research used a descriptive design because it described an existing phenomenon by using numbers to characterize individuals or a group, and assessed the nature of existing conditions (McMillan & Schumacher, 1993:34-35).

### **3.6 DATA COLLECTION INSTRUMENTS**

Survey research is an important form of descriptive research and involves acquiring information about one or more groups of people and their characteristics, opinions and attitudes by asking questions and tabulating their answers (Leedy & Ormrod, 2005:152). As it was the researcher's intention to collect information on the opinions of teachers and learners regarding authentic teaching and learning in Mathematics, survey research by means of a structured questionnaire was seen as suitable (Leedy & Ormrod, 2005:183). The use of questionnaires is also suitable to learn about a large population as was the case in this research (Leedy & Ormrod, 2005:183). In the context of the study, the researcher opted for a structured questionnaire to collect information.

### **3.6.1 The structured questionnaire**

As the research sample comprised a large number of participants, the questionnaire had to be more structured, closed and numerical (Cohen *et al.*, 2007:230). When a questionnaire is designed, a researcher has to keep in mind the type of data that will be generated by the questions and the statistical techniques that will be used to analyse it. The designing of a questionnaire requires a researcher to pay attention to the following: **appearance of questionnaire; question sequence; wording of questions and types of questions.** The above aspects create an opportunity for a researcher to select different options which will best suit the particular survey. When carefully considered and applied, the questionnaire will be a natural, ready to use instrument to elicit information (Maree & Pietersen, 2007b:158-159). In the following sections, the researcher explains how she dealt with each of the mentioned aspects in the design of the questionnaires that were used in the context of the study.

#### **3.6.1.1 Appearance of the questionnaire**

In Cohen *et al.* (2007:338), it is indicated that the appearance of a questionnaire is vitally important. The researcher applied the following principles suggested by Maree and Pietersen (2007b:159): the questionnaire was user-friendly, had a neat appearance and did not appear to be complicated (*cf.* Appendix D & E). The printing was neat and the font not too small. Clear instructions for completion were given and the printing was done on good quality paper.

#### **3.6.1.2 Question sequence**

According to Maree and Pietersen (2007b:160) questions should be ordered in such a way so as not to confuse the respondent. It is always good to have a short introduction explaining the survey to the respondent. A good sequence is to start with a few easy-to-answer, non-threatening questions like biographical detail that will put the respondent at ease. Then go to the topics relevant to the study. Keep questions on the same topic together and try to make the topics follow a logical order. Also try to keep questions together that require similar responses. The ordering of the questionnaire is important, for early questions may set the tone or the mindset of the respondent to later questions (Cohen *et al.*, 2007:336). Based on the suggestions by Cohen *et al.* (2007:336), the

researcher commenced with unthreatening biographical questions about the sample (e.g. age group, sex, occupation, years in post, qualifications) and then moved to statements that determined attitudes and perceptions.

### **3.6.1.3 Wording of questions**

Maree and Pietersen (2007b:160), indicate that it is very important to write the questions in such a way that the meaning of each will be the same for all respondents. A question that is not carefully worded may result in answers, and therefore data, that are meaningless. The following guidelines indicated by Maree and Pietersen (2007b:160) were used to compile the questions:

- The researcher used language that the respondents would understand- no slang or abbreviations were used.
- Ambiguity, lack of precision or vagueness was avoided - questions were clear, so that respondent exactly knew what was being asked.
- Double-barreled questions were avoided (e.g. “Do you work too slow or too fast?”).
- Leading questions were avoided. Respondents were not guided to respond to answers in a certain way (e.g. Do you agree that...”).
- No knowledge questions were asked to avoid that respondents had difficulty in answering questions .
- Double-negative questions were avoided (e.g. “ Don’t you agree that smoking is not good for you?”) as they are quite confusing.
- Statements with a “not” were avoided since they are confusing to respond to when using a Likert-type response scale.
- Items were formulated in the first person.
- Items were formulated as statements and not questions.

#### **3.6.1.4 Types of questions**

Bell (in Maree & Pietersen, 2007b:160) lists seven types of questions, which can be divided into two main categories, namely open (or unstructured) and closed (structured) questions.

Closed questions prescribe the range of responses from which the respondent may choose. Highly structured, closed questions are useful in that they can generate frequencies of responses amenable to statistical treatment and analysis. They also enable comparisons to be made across groups in the sample. They are quicker to code and analyse than word-based data and, often, they are directly to the point and deliberately more focused than open-ended questions (Cohen *et al.*, 2007:231). Closed questions provide for a set of responses from which the respondent has to choose one or sometimes more than one response (Maree & Pietersen, 2007b:161).

Open questions enable respondents to write a free account on their own terms, which often lead to irrelevant and redundant information. Open questions may require more time from respondents to complete as well as for the analysis. Furthermore, the data are not easily compared across respondents, and the responses are difficult to code and classify (Cohen *et al.*, 2007:231-322).

#### **3.6.1.5 Construction of the questionnaire items**

Two questionnaires were constructed to determine the provision of authentic teaching and learning in the Mathematics classroom. One questionnaire was constructed for teachers and the other one for learners. Each questionnaire comprised four sections that were based on the literature review namely:

- Section A: Biographical data
- Section B: General principles regarding the provision of authentic teaching, learning and assessment experiences in the Mathematics classroom (*cf.* 2.2, 2.3)
- Section C: The practical application of authentic teaching, learning and assessment (*cf.* 2.3-2.8)
- Section D: The utilization of teaching and assessment strategies (*cf.* 2.4.7; 2.8).

The questionnaires contained similar Likert-scale questions which were phrased to suit learners and teachers respectively. The use of a Likert rating scale is useful when behaviour, opinions, perceptions, attitudes or other phenomena of interest need to be evaluated (Leedy & Ormrod, 2005:185). In this case, the teachers' and learners' perceptions regarding the opportunities for authentic teaching and assessment were determined. The scale ranged from 1 to 4, as there was no "middle" response, to avoid the tendency of respondents often going with the middle answer. The scales were interpreted as follows: 1 representing "*Almost always*"/"*Strongly agree*", 2 representing "*Often*"/"*Agree*", 3 representing "*Sometimes*"/"*Disagree*" and 4 representing "*Very seldom*"/"*Strongly disagree*" in order to determine the frequency with which certain teaching actions and activities were utilized.

According to Maree and Pietersen (2007b:159) the time taken to complete a questionnaire should not exceed 20 minutes for adults and 30 minutes for learners. Furthermore, a questionnaire should not contain more than 120 items. The questionnaire used in the study complied with the above mentioned criteria. During the pilot study as well as the actual study, the teachers completed the 84-item questionnaire in 15 minutes and the learners completed the questionnaire in 30 minutes.

The questionnaire items were closed-ended statements, as the researcher merely wanted to determine the frequency with which certain teaching actions and activities were utilized by examining the opinions of learners and teachers. The use of a Likert-scale was effective to determine frequency and strength of attitude or opinion as envisaged in this research (McMillan & Schumacher, 2006:211).

### **3.6.1.6 Advantages of the use of questionnaires**

According to Leedy and Ormrod (2005:185) and Maree and Pietersen (2007b:157) utilizing a questionnaire for research has some advantages and disadvantages:

Some of the advantages of the use of questionnaires refer to the fact that paper- pencil questionnaires can be sent to a large number of people which saves the researcher travel expenses and postage is typically cheaper than a long distance telephone call.

- In addition to the aforementioned, respondents can respond to questions with the assurance that their responses will be anonymous. Responses to questionnaire

items are more truthful than they would be in a personal interview, particularly when talking about sensitive or controversial issues. Many respondents can also complete the questionnaire in a short space of time, and respondents can be reached across long distances. If researchers administer their questionnaires personally, they can immediately assist with issues in the questionnaires which are not clear to the respondents, ensuring an optimal response rate.

The use of questionnaires however also poses some disadvantages. Some of the disadvantages refer to different interpretations of the questionnaire items and limited control over what happens in the field when the primary researcher does not control the completion of the questionnaire. Furthermore, costs could be rather high when using standardized questionnaires

### **3.6.1.7 Administration of questionnaires**

There are different ways of administering questionnaires, namely self-administration, investigator-administration, postal surveys, telephone surveys and psychological tests (Maree & Pietersen, 2007b:157).

There are two types of self-administered questionnaires: those that are completed in the presence of the researcher and those that are filled in when the researcher is absent (e.g. at home, in the workplace) (Cohen *et al.*, 2007:344). In group administration of questionnaires, the researcher waits while respondents complete the questionnaires (Maree & Pietersen, 2007b:157). The researcher opted for group administration of the questionnaires based on the following (Cohen *et al.*, 2007:344) revealed in the literature for the use of self-administered questionnaires: group administration enabled rapid completion on one occasion, any queries or uncertainties were addressed immediately by the researcher, a good response rate was ensured as well as the correct completion of all questions.

The researcher also acknowledges that the use of self-administered questionnaires also comes with a number of disadvantages. These *inter alia* refer to the fact that respondents may feel uncomfortable in the presence of the researcher and may need extra time to think and complete the questionnaire. It places pressure on the researcher

to attend at an agreed time and place which could be time-consuming and costly (Maree & Pietersen, 2007b:157).

### 3.6.1.8 Reliability and validity of the quantitative research design and questionnaire

Reliability of an instrument means that if the same instrument is used at different times or administered to different subjects from the same population, the findings should be the same. In other words, reliability is the extent to which a measuring instrument is repeatable and consistent (Pietersen & Maree, 2007c:215).

Before the actual research commenced, a pilot study was conducted to determine the reliability, validity and practicability of the questionnaire items (Cohen *et al.*, 2007:341). A pilot study was conducted with 50 learners and 50 teachers who were not part of the sample to determine whether the questionnaire complied with reliability criteria and to determine whether the items were clear and unambiguous. A Cronbach alpha coefficient was also calculated for each of the questionnaire sections for the actual study for learners and teachers respectively. Table 3.1 indicates the results for the pilot study and the actual study.

**Table 3.1: Cronbach alpha coefficients: pilot study and actual study**

Questionnaire section		Learners' <i>a</i>	Teachers' <i>a</i>
B1: Information on the provision of authentic teaching experiences (items 1-17)	Pilot	0.744	0.823
	Actual	0.808	0.854
B2: Understanding of the provision of authentic learning experiences (items 1-20)	Pilot	0.672	0.912
	Actual	0.781	0.801
C: Practical application of authentic teaching and learning	Pilot	0.668	0.793
	Actual	0.826	0.867
D: Teaching and assessment methods and strategies	Pilot	0.868	0.726
	Actual	0.874	0.914

The Cronbach alpha coefficient was calculated to determine the internal consistency of the various questionnaire sections. The Cronbach alpha is a reliability coefficient that calculates the extent to which items, such as found in a questionnaire, are correlated positively to one another (Akbaba, 2006:183). Cronbach alpha measures consistency among individual items in a scale (Simon, 2008). Sekaran (2000) points out that the internal consistency reliability becomes higher as the Cronbach alpha moves closer to 1.

In most Social Sciences, a Cronbach alpha coefficient between 0.7 and 0.8 is yielded as acceptable when working with a set of items to be considered on a scale, but some use 0.75 or 0.80, while others are lenient and accept 0.60 (Simon, 2008). According to Simon (2008) and Garson (2008), 0.60 could be seen as in order for an exploratory study. Table 4.2 indicates that the questionnaire for learners and teachers complied with reliability criteria.

Inter-item correlations were also determined for the items listed in the various sections of the questionnaire. An inter-item correlation is used to judge the reliability of the instrument by estimating how well the items that reflect the same construct yield similar results (Trochim, 2006). The following results that are reflected in Table 3.2 were calculated for the various questionnaire constructs for the pilot study and the actual study for learners and teachers respectively.

**Table 3.2: Inter-item correlation: pilot study and actual study**

<b>Questionnaire constructs</b>		<b>Learners Inter-item correlation</b>	<b>Teachers Inter-item correlation</b>
B1: Information on the provision of authentic teaching experiences (items 1-17)	Pilot	0.027	0.027
	Actual	0.051	0.037
B2: Understanding of the provision of authentic learning experiences (items 1-20)	Pilot	0.142	0.024
	Actual	0.153	0.028

C: Practical application of authentic teaching and learning	Pilot	0.464	0.018
	Actual	0.342	0.016
D: Teaching and assessment methods and strategies	Pilot	0.052	0.078
	Actual	0.042	0.056

According to Trochim (2006), an inter-item correlation of between 0.15 and 0.5 yields an acceptable value. Both questionnaires complied with these criteria.

The observation schedule was also verified with the study leader of the researcher to determine whether the determined observation categories corroborate with what the literature reveals on authentic teaching and learning, and whether the observations would be manageable.

Before the research was conducted, the researcher determined whether the choice of a quantitative research design could be regarded as valid for the study.

### **Validity of quantitative research**

Validity and its measurement play an important part in determining the appropriate research design to employ. Validity refers to the accuracy of research data (Burton & Bartlett, 2005:27). For the purpose of this research, criteria for internal, external, construct and statistical conclusion validity were considered (Maree & Van der Westhuizen, 2007:37; McMillan & Schumacher, 2006:134-142).

- **Internal validity**

Internal validity of a research study is the extent to which its design and the data it yields allow the researcher to draw accurate conclusions about cause-and-effect and other relationships within the data (Leedy & Ormrod, 2005:97). According to McMillan and Schumacher (2006:186), internal validity refers to the extent of control the researcher has over variables. In the context of this study, the internal validity was supported by the fact that the survey research could be regarded as suitable and appropriate to collect information about perceptions and opinions of teachers and learners. The researcher did not control for the influence of the various biographic

variables on the outcomes of the findings, which could be regarded as a limitation in the study.

- **External validity**

External validity refers to the extent to which the conclusions drawn can be generalized to other contexts (Leedy & Ormrod, 2005:99). For quantitative designs there are two general categories of external validity, namely population external validity and ecological external validity (McMillan & Schumacher, 2001:193). The external validity of this study was enhanced by the fact that the study was conducted in a real-life setting (Leedy & Ormrod, 2005:99). A limitation related to external validity is evident in the study, as the sample was not randomly selected and therefore the researcher cannot generalize to other people in the population (McMillan & Schumacher, 2001:193).

- **Construct validity**

Construct validity *inter alia* refers to the use of more than one method of data collection (McMillan & Schumacher, 2006:141). Although observations were used in conjunction with the questionnaires, to support the results obtained by the questionnaire, the researcher acknowledges that by adding a qualitative component to the research, a clearer understanding of the research problem could have been obtained.

- **Statistical conclusion validity**

In the context of the study, the researcher is of the opinion that threats to statistical conclusion validity were avoided as appropriate statistical tests were utilized by the Statistical Consultation Services of the North-West University, Vaal Triangle Campus to analyse the data obtained from the questionnaires (*cf.* 3.9) (McMillan & Schumacher, 2006:134).

### **Validity of the questionnaire**

The validity of an instrument refers to the extent to which it measures what it is supposed to measure (Pietersen & Maree, 2007c:216). Test validity is the extent to which inferences made on the basis of scores from an instrument are appropriate, meaningful and useful. Validity is a judgment of the appropriateness of a measure for

specific inferences or decisions that result from the scores that are generated. Validity is assessed depending on the purpose, population and environmental characteristics in which measurement takes place (McMillan & Schumacher, 1993:167). In this research, validity of the questionnaire was arrived at by considering face, content and construct validity.

**Face validity** refers to the extent to which an instrument “looks” valid. In other words, does the instrument measure what it is supposed to measure? This type of validity cannot be quantified or tested, but any instrument should be scrutinized by experts in the field to ensure a high degree of face validity (Pietersen & Maree, 2007c:217). Face validity is the extent to which an instrument looks as if it is measuring a particular characteristic (Leedy & Ormrod, 2005:92). In this research the instrument complied with the criteria for face validity as it measured the provision or practical application of authentic teaching and learning in the Mathematics classroom. It thus measured what it was supposed to measure, and the researcher received confirmation in this regard by her study leader and a knowledgeable colleague in the field of study that the questionnaire measured the construct in question.

**Content validity** is the extent to which a data collection instrument is a representative sample of the content area being measured. The items or questions should reflect the various parts of the content domain in appropriate portions (Leedy & Ormrod, 2005:92). This kind of validity refers to the extent to which the instrument covers the complete content of the particular construct that it is set out to measure .e.g. if an instrument is developed to measure intelligence, there should be items on all the different aspects of intelligence, namely verbal reasoning, analytical ability and so on. To ensure the content validity of an instrument, the researcher usually presents a provisional version to experts in the field for their comments before finalizing the instruments (Pietersen, & Maree, 2007c:217). The content validity for the data collection instrument utilized in the research is supported by the fact that the specific test items were constructed strictly and in equal proportions according to the essential components indicated in the literature as being part of the provision of authentic teaching and learning in the Mathematics classroom.

**Construct validity** is needed for standardization and has to do with how well the constructs covered by the instrument are measured by different groups of related items (Pietersen & Maree, 2007c:217). Unfortunately, the researcher could not locate a similar questionnaire that could be administered to the sample to provide a measure of comparison for the results obtained with the self-constructed questionnaire. Construct validity of an instrument should first be examined and shown to be present before it can be said to be a standardized instrument (Pietersen & Maree, 2007c:217). Construct validity is of primary importance with instruments that assess a trait or theory that cannot be measured directly, such as when the purpose of the instrument is to measure an unobservable trait like intelligence, creativity or anxiety. Good construct validity is demonstrated by placing the trait that is measured within the context of a clear and compelling theoretical framework (McMillan & Schumacher, 1993:225).

Construct validity is the extent to which an instrument measures a characteristic that cannot be directly observed, but must be inferred (Leedy & Ormrod, 2005:92). The data collection instrument used in this research definitely measures the construct in question, namely provision of authentic teaching and learning in the Mathematics classroom. All the sections of the questionnaire focused on different teaching methods, assessment techniques and strategies that relate to authentic teaching and learning in the Mathematics classroom. The researcher verified the items included in the questionnaire with the study leader to make sure the items measured the construct in question.

### **3.6.2 Observations**

In order to support or refute the data obtained by the questionnaires and to provide a deeper understanding of the data obtained with the questionnaires, the researcher also decided to do observations.

The distinctive feature of observation as a research process is that it offers an investigator the opportunity to gather live data from naturally occurring natural social situations. The researcher directly looks at what is taking place in situations rather than relying on second-hand accounts (Cohen *et al.*, 2007:396). Observation is the systematic process of recording the behavioural patterns of respondents, objects and occurrences without necessarily questioning or communicating with them. It is an everyday activity whereby we use our senses (seeing, hearing, touching, smelling and

tasting) - but also our intuition to gather bits of data. It is used to enable the researcher to gain a deeper insight and understanding of the phenomenon being observed (Nieuwenhuis, 2007:83-84).

Observation is a particular kind of data-gathering, one in which the researcher directly observes, visually and auditory, some phenomenon and systematically records the resulting observations. The observer has predetermined specific categories of behaviour that will be recorded. What he/she will observe is determined before the research is conducted (McMillan & Schumacher, 1993:42).

In quantitative research, an observation study focuses on a particular aspect of behaviour (Leedy & Ormrod, 2005:180). The behaviour can be rated for frequency, accuracy, intensity, maturity or some other dimension. In this particular research, the observation focused on the frequency of incidences in the classroom that enhanced authentic teaching and learning in the Mathematics classroom.

### 3.6.2.1 How to observe

Observation is an essential data gathering technique as it holds the possibility of providing us with an insider perspective of the group dynamics and behaviour in different settings. It allows the researcher to hear, see and begin to experience how the setting is socially constructed in terms of power, communication lines, discourse and language (Nieuwenhuis, 2007:84). As you get involved in this, you build a relationship with the respondents. Before using observation as a data-gathering technique, the researcher has to define the purpose and focus of the observation and know exactly what he/she wants to observe.

During the initial phase of the observation process, the researcher adopts a relatively passive role. The researcher has to protect the respondents' integrity and anonymity. The researcher has to explore how respondents normally deal with the situation, and be frank and truthful about his/her role as observer (Nieuwenhuis, 2007:84). Morrison (in Cohen *et al.*, 2007:396) asserts that observation enables the researcher to gather data on: **the physical setting** e.g. the physical environment and its organization; **the human setting** organization of people, the characteristics and make-up of the groups/ individuals being observed (i.e. gender, class, etc.); **the interactional setting** (the

resources and their organization; pedagogic styles, curricula and their organization). In the context of the study the researcher was mainly interested in the interactional setting in the classroom.

### 3.6.2.2 Types of observation

According to Nieuwenhuis (2007:85), the observer can fulfill the following roles:

- Complete observer
- Observer as respondent
- Respondent as observer
- Complete respondent

**Complete observer:** Here the researcher is a non-respondent observer looking at the situation from a distance. The researcher does not become immersed in the situation.

**Observer as respondent:** The researcher gets into the situation, but focuses mainly on his/her role as observer in the situation. The researcher may look for patterns of behaviour in a particular community to understand the assumptions, values and beliefs of the respondents, and to make sense of the social dynamics – but the researcher remains uninvolved and does not influence the dynamics of the setting.

**Respondent as observer:** The researcher becomes part of the research process and works with respondents in the situation to design and develop intervention strategies. The researcher is a respondent and may intervene in the dynamics of the situation and even try to alter it.

**Complete respondent:** The researcher gets completely involved in the setting, to such an extent that those observed do not know that they are the subjects of the observations.

For the purpose of this research, the researcher and the co-observer were complete observers who looked at the teaching and learning situation from a distance. The researcher looked at the provision and practical application of teaching and learning methods as well as assessment strategies during the teaching and learning of

Mathematics. The researcher remained uninvolved and did not influence the dynamics of the classroom setting.

### 3.6.2.3 Recording observations

According to Cohen *et al.*, (2007:398-405) and Nieuwenhuis (2007:85), in recording observational data, researchers use the following:

- **Anecdotal records:** These are short descriptions of basic actions observed capturing key phrases or words, and should be objective with no self-reflective notes.
- **Running records:** These are more detailed continuous or sequential accounts of what is observed. The focus is not only on actions, but also on the situation and trying to describe actions in the context in which they occur.
- **Structured observations:** Here the researcher identifies predetermined categories of behaviour that they would like to observe. These categories are distilled from the literature and have been developed into checklists or rating systems to record and score predetermined actions or behaviours.

In the context of the study, the researcher utilized structured event sampling (Cohen *et al.*, 2007:400). Event sampling involved the use of a sign system which required a tally code to be entered against each of the incidences indicated in the observation schedule when it was observed (Cohen *et al.*, 2007:400) (*cf.* Appendix F). The researcher and the co-observer jointly decided to utilize a forward slash (/) each time evidence for an observed behaviour was identified.

A structured observation is very systematic and enables the researcher to generate numerical data from the observations. Numerical data, in turn, facilitate the making of comparisons between settings and situations, and frequencies, patterns and trends to be noted or calculated. Here the observer adopts a passive, non-intrusive role, merely noting down the incidence of the factors being studied. Observations are then entered on an observational schedule (Cohen *et al.*, 2007:398).

In recording observations, the researcher captured two dimensions: a description of what was observed (i.e. detailed descriptions of what actually took place which should not include any value judgment) and a reflection of what happened (i.e. her own thoughts or ideas about the meaning of what was observed). As suggested by Nieuwenhuis (2007:85-86) the researchers should compile accurate field notes during the observation. One should record what you see, hear and experience as if you are seeing it for the first time, and record both verbal and non-verbal behavior. Reflection on an observation should be done as soon as possible after the event and should include the researcher's hunches (it appears; it seems to be) (Nieuwenhuis, 2007:86).

#### **3.6.2.4 Structuring of an observation schedule**

An observation schedule was constructed with a rating scale to evaluate the frequency with which opportunities/incidences for the provision of authentic teaching and learning in the Mathematics classroom, occurred. Based on the information gathered through the literature review, the items in the observation schedule were constructed to correspond with the practical application of authentic teaching and learning in the Mathematics classroom. The observation schedule or rating scale comprised of the following four sections (*cf.* Appendix F).

- Section A: General principles of authentic teaching and learning experiences in the Mathematics classroom
- Section B: Practical application of authentic teaching and learning
- Section C: Application of teaching strategies
- Section D: Application of assessment strategies

The sections of the observation schedule corresponded with the sections of the questionnaire as the researcher wanted to verify the data obtained from the questionnaire with the data obtained from the observations.

During the observation, two people i.e. the researcher and the co-observer rated the same behaviours independently, without knowledge of one another's ratings. Afterwards, the observations were compared before final conclusions were drawn. In

total, 18 observations were conducted, after which the researcher and the co-observer compiled a summary based on the total observations for all the teachers for each of the sections in the observation schedule (*cf.* 4.5). Two teachers representing each of the Grades, 4, 5 and 6, were randomly selected from the group of teachers who initially completed the questionnaires. The six teachers were each observed three times in their classrooms while they were busy teaching Mathematics to their learners. Each of the observation sessions lasted for 30 minutes.

The observations were unannounced and consent to do so was obtained from the school principals and the teachers. Each of the teachers provided dates to the principal where tests or exams were scheduled in their classrooms, to avoid the researcher coming for observation on a day when no teaching was going to take place. In order to avoid that the observations became threatening to the teachers; the researcher explained the purpose of the observations to each of the teachers beforehand, and broadly highlighted the aspects of their classroom practice that would be observed. The observations had to be unannounced to avoid that participants prepare in advance to teach differently to what they normally do, because they knew they were going to be observed (Cohen *et al.*, 2007:411).

### **3.6.2.5 Advantages and disadvantages of observations**

According to Leedy and Ormrod (2005:180), an observation study is advantageous because it can yield data that portrays much of the richness and complexity of human behaviour. Observations according to predetermined criteria constructed a complex yet integrated picture of how the teachers and the learners in the sample act and interact in the Mathematics classroom. A disadvantage of observations is that the researcher (especially a novice researcher) won't always know what aspects are most important to look for at the beginning. The researcher may alter what people say and do and how events unfold (Leedy & Ormrod, 2005:145). The researcher tried to avoid that these disadvantages compromised the collection of data by constructing an observation schedule with specific criteria to guide the observation and also had the assistance of a colleague in the field who acted as a co-observer which provided a way of checking whether the observations made were reliable and valid.

### 3.6.2.6 Reliability of the observations

A distinctive feature of using observation in research is that it offers a researcher or an investigator the opportunity to gather “live” data from naturally occurring social situations. In this way, the researcher is able to look directly at what is taking place in the situation, rather than relying on second-hand accounts. The use of immediate awareness or direct cognition as a principal mode of research thus has the potential to yield more valid data than would be the case with mediated or inferential methods (Cohen *et al.*, 2007:396). Cooper and Schindler (2001:374) indicate that what people do may differ from what they say they do, so an observation provides a reality check. Observation is also enabling a researcher to look afresh at everyday behaviour that might otherwise be taken for granted, expected to go unnoticed (Cohen *et al.*, 2007:396). In this regard the researcher used observations to verify the data obtained from the questionnaires. Moyles (in Cohen *et al.*, 2007:396) indicates that observational data are sensitive to contexts and they demonstrate strong ecological validity. This enables researchers to understand and see things that might otherwise be unconsciously missed, to discover things that respondents might not freely talk about in an interview situation, to move beyond perception-based data (e.g. opinions in interviews) and to access personal knowledge. Because observed incidents are less predictable, there is certain freshness to this form of data collection that is often denied in other forms, e.g. a questionnaire (Cohen *et al.*, 2007:396).

An observation focuses on a particular aspect of behaviour. In the context of the study, the observed behaviour was quantified and each occurrence of behaviour was counted to determine its overall frequency. The researcher strove to be as objective as possible in assessing the behaviour being studied. To maintain such objectivity, the researcher used the following strategies:

- She defined the behaviour being studied in a precise, concrete manner so that the behaviour was easily recognized when it occurred. This prevented that the observer paid selective attention to certain aspects of the classroom teaching and learning, and ignoring others.
- The researcher and a co-observer rated the frequency of the same behaviours independently without knowledge of one another’s ratings.

- The co-observer was trained to follow the same criteria as the researcher when counting or evaluating the behaviour.

Furthermore, the researcher adhered to the following guidelines indicated by Cohen *et al.* (2007:410-411) to enhance the reliability of the observations.

- The researcher and the co-observer decided in advance what would count as valid evidence for a judgment to be made.
- The researcher and the co-observer did not know any of the teachers who were observed which enabled them to distance themselves from the teachers and the context of the situation and to avoid the risk of being biased.

As indicated by Cohen *et al.* (2007:400) the observation schedule was pilot tested in a Grade 4 Mathematics classroom that was not part of the actual observation study. The pilot study assisted the researcher and the co-observer to establish what would count as evidence for a specific behaviour and how frequent observations would be tallied. As there were quite a number of issues to be observed, the researcher and co-observer decided to enter observations every five minutes during the 60 minute observation period.

An observational study involves considerable advance planning, meticulous attention to detail, a great deal of time and the help of one or more research assistants. Ultimately an observational study can yield data that portrays much of the richness and complexity of human behaviour (Leedy & Ormrod, 2005:180).

### **3.7 POPULATION AND SAMPLE**

In order to decide on a suitable method of sampling for the study, the researcher first had to investigate different sampling methods. There are two major classes of sampling methods, namely probability sampling and non-probability sampling (Leedy & Ormrod, 2005:199).

#### **3.7.1 Probability sampling**

In probability sampling, the researcher can specify in advance that each segment of the population will be represented in the sample. The components of the sample are

chosen from the larger population by a process known as random selection. Random selection means choosing a sample in such a way that each member of the population has an equal chance of being selected (Leedy & Ormrod, 2005:199). In sampling methods belonging to this class, each element in the population has a known non-zero probability of being selected. Also, the selection of elements is completely random. An objective mechanism is used in the selection procedure. There should be no human or subjective interference in this process (Maree & Pietersen, 2007c:172).

**Examples of this method are:**

#### **3.7.1.1 Simple random sampling**

Simple random sampling is the least sophisticated of all sampling designs. The sample is chosen by simple random selection, whereby every member of the population has an equal chance of being selected (Leedy & Ormrod, 2005:201).

#### **3.7.1.2 Stratified random sampling**

In stratified random sampling, the researcher samples equally from each one of the layers in the overall population. This type of sampling has the advantage of guaranteeing equal representation of each of the identical strata (Leedy & Ormrod, 2005:202).

#### **3.7.1.3 Cluster sampling**

Cluster sampling is similar to stratified sampling in the sense that the population is also divided into a number of non-overlapping groups. However, these groups are usually much smaller than strata. They are called clusters, and this method involves the random selection of a number of clusters from which either all the elements or a randomly selected number form the sample (Maree & Pietersen, 2007c:176).

#### **3.7.1.4 Systematic sampling**

Systematic sampling involves selecting individuals or perhaps clusters according to a predetermined sequence. The sequence must originate by chance, e.g. we might scramble a list of units that lie within the population of interest and then select every 10th unit on the list (Leedy & Ormrod, 2005:203).

### **3.7.2 Non-probability sampling**

In non-probability sampling, the researcher has no way of forecasting or guaranteeing that each element of the population will be represented in the sample, and some members of the population have little or no chance of being sampled (Leedy & Ormrod, 2005:206). Non-probability sampling does not make use of random selection of population elements and it would therefore be dangerous to draw important conclusions about the population (Maree & Pietersen, 2007c:176).

**Examples of this method are:**

#### **3.7.2.1 Convenience sampling**

This method refers to situations when population elements are selected based on the facts that they are easily and conveniently available. It is usually quick and cheap, but does not result in representative samples (Maree & Pietersen, 2007c:177).

#### **3.7.2.2 Quota sampling**

In this method of sampling, the researcher first has to identify categories of people that need to be in the sample and the required number (quotas) in these categories. Sampling is then done by means of convenience sampling until the quotas have been reached (Maree & Pietersen, 2007c:177).

#### **3.7.2.3 Purposive sampling**

In purposive sampling, people or other units are chosen for a particular purpose. For instance, we might choose people who, we have decided, are typical of a group of those who represent diverse perspective on an issue (Leedy & Ormrod, 2005:206).

#### **3.7.2.4 Snowball sampling**

This method is often used in cases where the population is difficult to find or where the research interest is in an inter-connected group of people. The starting point is making contact with one or more people who belong to the population. They are interviewed or handed a questionnaire and then asked for information about others who have the same characteristics and who can be contacted next (Maree & Pietersen, 2007c:177).

### **3.7.3 The selection of the sample for the study**

In cases of a large population, the researcher will not study the entire population. Instead, he/she will select a sample of that population (Leedy & Ormrod, 2005:198). The researcher can use the results obtained from the sample to make generalizations about the entire population. As the population of a research is characterized according to all possible elements that could be included in the research, the study population for this research comprised the learners and Mathematics teachers of the Intermediate Phase of primary schools in the Ennerdale/Lawley area of D11 (Johannesburg South) in Gauteng. As the researcher focused specifically on Intermediate Phase Mathematics classrooms, the group of teachers and learners were purposively selected (Nieuwenhuis, 2007:79). Furthermore, the researcher works as a Mathematics teacher in the D11 district, which allowed her easy access to the schools. In this sense, the researcher also made use of a convenient selection of research respondents. The study population comprised the following respondents:

- 78 primary schools
- 234 teachers
- 9360 learners

Due to time, financial and logistical constraints, the sample in this research comprised of 8 randomly selected primary schools in this district ( $n=8$ ). This selection is in line with the views of Seaborg, Grinnell and Williams (cited by Vermeulen, 1998:59), that a 10% sample size in most cases is adequate to control for sampling error. In random sampling, all schools in this particular district stand a chance of being selected (Leedy & Ormrod, 2005: 201). A list of all primary schools was obtained from the district and the researcher randomly selected 8 schools from the list. As this is predominantly a Black and Coloured community, 4 schools were Black-dominated and 4 were dominated by Coloureds. This implies that the learners and teachers who took part in the study were representative of the Black and Coloured populations.

For the purpose of this research, the sample used for the completion of the questionnaires comprised of the following respondents: in each school one willing Grade 4, 5 and 6 class and their respective Mathematics teachers and learners were

approached to take part in the study. In total, eight Grade 4; eight Grade 5 and eight Grade 6 classes of approximately 40 learners per class (960 boy and girl learners) (n=960) and 24 male and female, teachers (n=24), who differed according to age, their training levels and experience in Mathematics teaching, were invited to take part in the research. However, only 720 learners were ultimately willing to become involved in the research.

For the purpose of the observations, two teachers representing each of Grades, 4, 5 and 6, who initially completed the questionnaires, were requested to take part willingly in the observations.

In summary, at the onset of the study the researcher made use of purposive and convenient sampling, followed by a random selection of schools and the inclusion of willing teachers and learners for the completion of the questionnaires and willing teachers who took part in the observations.

### **3.8 HYPOTHESES**

As the researcher wished to determine whether there was a difference between the teacher and learner responses regarding the application of the principles of authentic teaching and learning, the following null and alternative hypotheses were formulated for the study:

$H_0$  = There will be no statistically significant difference between the learner and teacher responses regarding the application of the principles of authentic teaching and learning in the Mathematics classroom.

$H_1$  = There will be a statistically significant difference between the learner and teacher responses regarding the application of the principles of authentic teaching and learning in the Mathematics classroom.

### **3.9 DATA ANALYSIS**

The Statistical Consultancy Services of the North West University, Vaal Triangle was consulted for assistance in the capturing, analysis and interpretation of the data collected. The collected data was captured, analysed and interpreted, using descriptive statistics. Descriptive statistics are used to organize and summarize data meaningfully

in order to promote an understanding of the data characteristics (Pietersen & Maree, 2007a:185). Frequencies, means and percentages were calculated for the various responses to the questionnaire items in order to determine teachers' understanding of authentic teaching and learning, and the extent to which opportunities for authentic teaching and learning are provided. These results were presented in graphical and tabular form. Two-way frequency tables were used to explore teacher and learner responses for the various questionnaire items simultaneously. This provided an immediate comparison of the teacher and learner responses.

As the research wanted to go beyond summarizing and describing data, inferential statistics were also utilized (Pietersen & Maree, 2007b:198). Inferential statistics were utilized to interpret differences between the teachers and learners' responses in order to determine statistical significance and effect in practice. T-tests and Cohen's d were utilized for these purposes. In the context of the study, p-values smaller than the 0.5 were regarded as significant and values larger than 0.5 as non-significant (Pietersen & Maree, 2007d:230).

The following interpretations were allocated to Cohen's d:

0.2: small effect in practice

0.5: medium effect in practice

0.8: large effect in practice (Steyn, 2005:20)

The data obtained by the observation were analysed by means of descriptive statistics.

Frequencies were calculated for the various observations in order to determine the nature of the implementation of authentic teaching and learning in the Mathematics classrooms.

### **3.10 CHAPTER SUMMARY**

In order to determine whether authentic teaching and learning take place in Mathematics classrooms, the researcher conducted quantitative research (*cf.* 3.4) framed within a positivistic paradigm (*cf.* 3.3) through the use of questionnaires and observations (*cf.* 3.6) to establish teacher and learner perceptions regarding the

opportunities for authentic teaching and learning, and to provide a picture of the characteristics of the classroom teaching and learning in Mathematics classrooms of a conveniently selected sample of teachers ( $n = 24$ ) and learners ( $n = 960$ ) from the Johannesburg South District of the Gauteng Education Department (*cf.* 3.7).

The next chapter will elaborate on the analysis and interpretation of the data obtained with the questionnaires and the observations.

# CHAPTER FOUR

## DATA ANALYSIS AND INTERPRETATION

### 4.1 INTRODUCTION

The previous chapter outlined the empirical research design that was employed to collect data in order to determine to what extent authentic teaching and learning take place in Mathematics classrooms. This chapter deals with the analysis and interpretation of the collected data. The analysis focuses on the data obtained through the questionnaires and the observations. The following aspects will form part of the discussion in Chapter Four:

- Data analysis: questionnaires
- Teacher and learner responses to the questionnaire statements
- Teacher and learner responses to the questionnaire statements: a comparison
- Data analysis: teacher observation
- Triangulation of questionnaire and observation data

### 4.2 DATA ANALYSIS: QUESTIONNAIRES

#### 4.2.1 Return rate of questionnaires

In Table 4.1 the return rate for the questionnaires administered to teachers and learners are reported.

**Table 4.1: Return rate of questionnaires**

	Number distributed	Number returned	Return rate %	Incomplete questionnaires	%	Completed questionnaires	%
Learners	720	720	100	280	38.8	440	61.11
Teachers	24	24	100%	0	0%	24	100%

The above table indicates that a number of learner questionnaires were not fully completed (38.8%) and could therefore not be taken into consideration for the data analysis. As the researcher had quite a large number of learner respondents, 440 of the initial 720 questionnaires could be utilized for the data analysis.

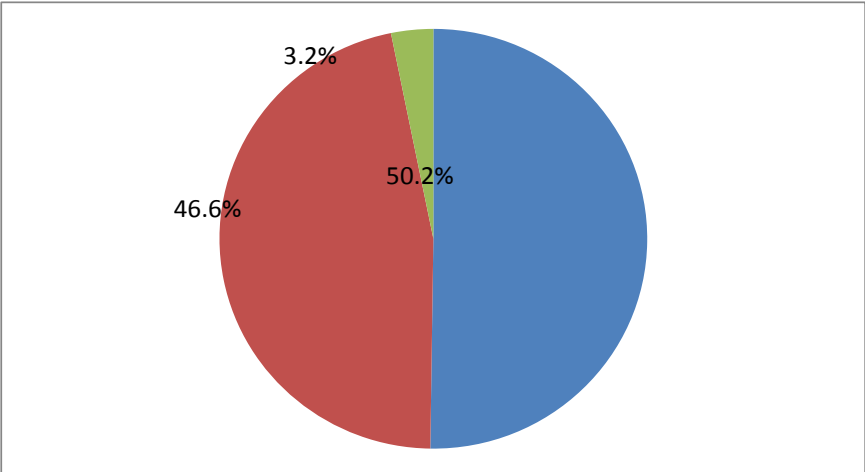
**4.2.2 Biographic information of learner respondents**

Tables 4.2 to 4.6 indicate the biographic information of the learner respondents. For the purpose of the graphs the data was rounded off to the nearest integer.

**4.2.2.1 Gender**

**Table 4.2: Gender of learner respondents**

	<b>Variables</b>	<b>f</b>	<b>%</b>
1	Females	221	50.2
2	Male	205	46.6
3	Not responded	14	3.2
4	Total	440	100

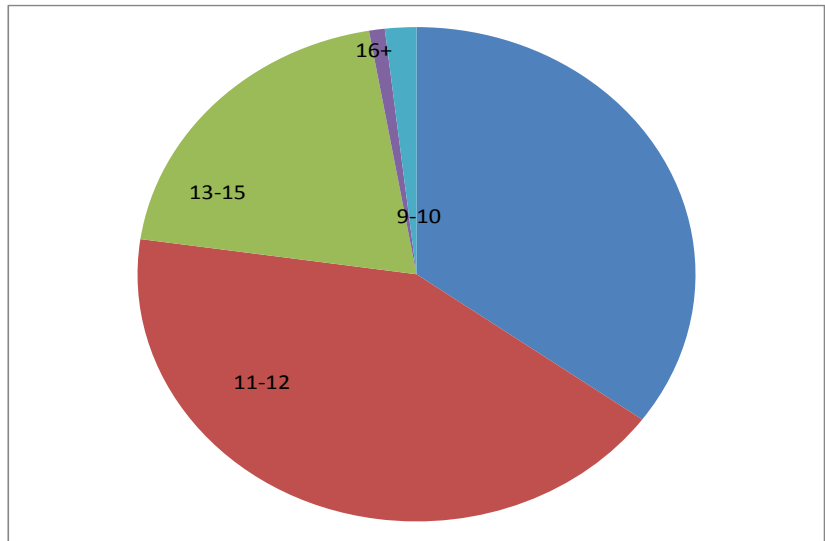


The majority of the respondents (50.2%) were female learners and 46.6% were male learners.

#### 4.2.2.2 Age

**Table 4.3: Age of learner respondents**

	Variables	f	%
1	9-10	154	35
2	11-12	186	42.3
3	13-15	88	20
4	16+	4	0.9
5	Not responded	8	1.8
Total		440	100

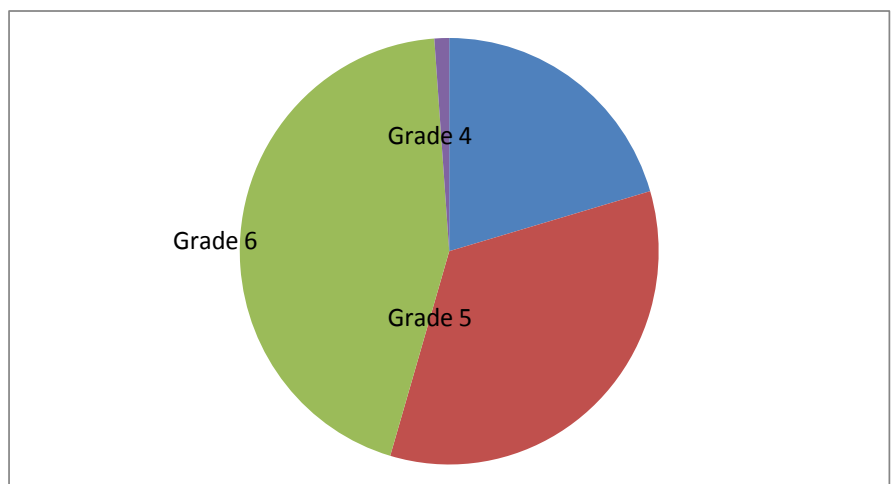


Most of the respondents were 11-12 years of age (42.3%), 35% were 9-10 years of age, 20% were 13-15 years of age and 0.9% were 16 years and older.

#### 4.2.2.3 Grade

**Table 4.4: Grade of learner respondents**

	Variables	f	%
1	Grade 4	90	20.5
2	Grade 5	150	34.1
3	Grade 6	195	44.3
4	Not responded	5	1.1
5	Total	440	100

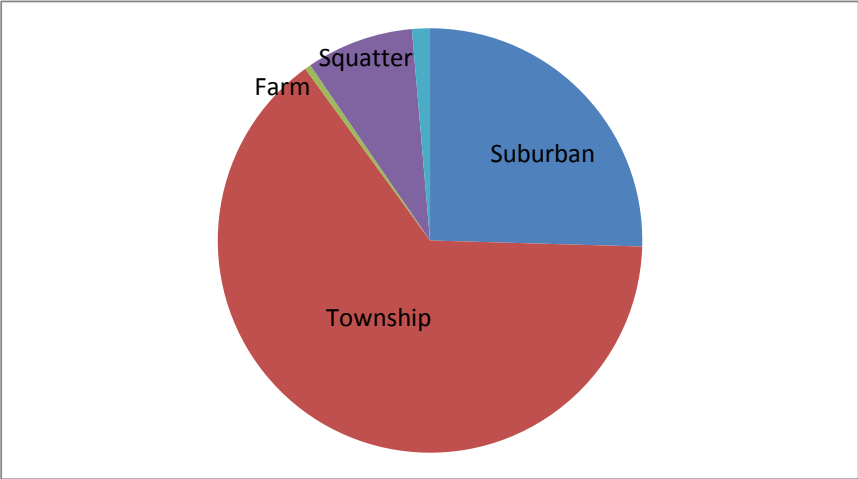


The majority of the respondents (44.3%) were in Grade 6, 34.1% were in Grade 5, and 20.5% were in Grade 4.

**4.2.2.4 School location**

**Table 4.5: School location of learner respondents**

	<b>Variables</b>	<b>f</b>	<b>%</b>
1	Suburban	112	25.4
3	Township	284	64.5
4	Farm	2	0.5
5	Squatter areas In townships	36	8.2
6	Not responded	6	1.4
7	Total	440	100

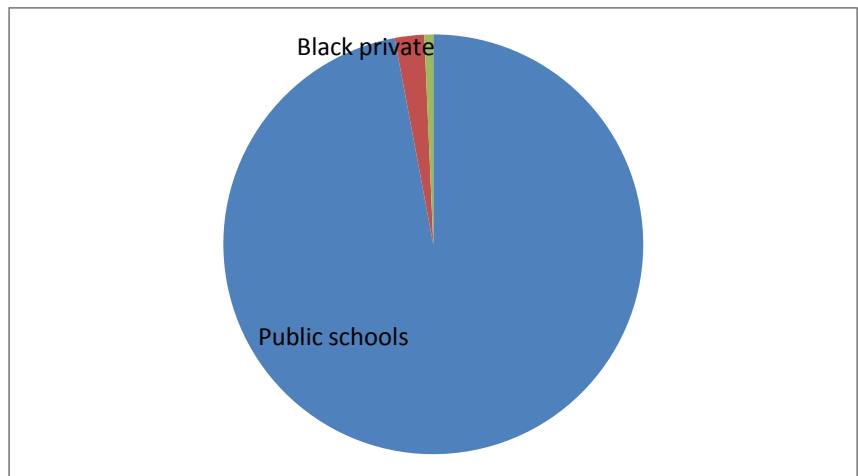


Most of the respondents (64.5%) attended township schools, 25.4% were in suburban schools, 8.2% were in schools in informal settlements (squatter areas) and 0.5% attended farm schools.

#### 4.2.2.5 Type of school

**Table 4.6: Type of school of respondents**

	Variables	f	%
1	Public	427	97
2	Black Private	10	2.3
3	Not responded	3	0.7
4	Total	440	100



The majority of the respondents (97%) attended public schools and 2.3% were in Black private schools. The research was conducted mainly in public schools as there are more public schools than private schools in the Johannesburg South District.

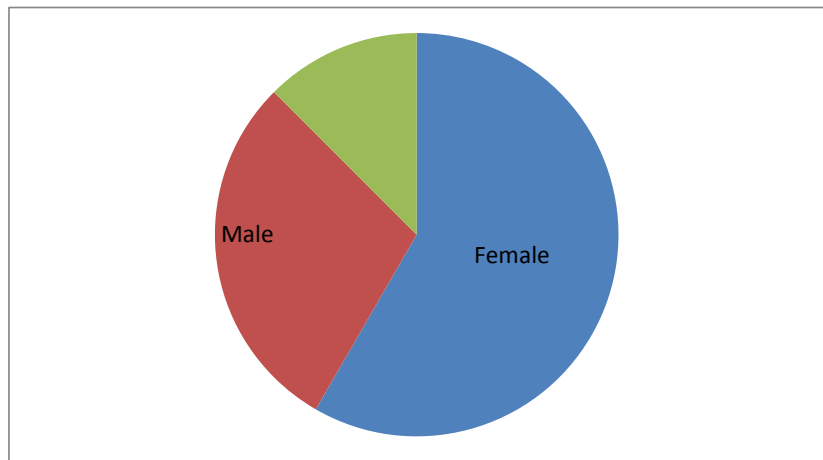
#### 4.2.3 Biographic information of teacher respondents

Tables 4.7-4.14 indicate the biographic information of the teacher respondents.

#### 4.2.3.1 Gender of teacher respondents

**Table 4.7: Gender of teacher respondents**

	<b>Variables</b>	<b>f</b>	<b>%</b>
1	Females	14	58.3
2	Male	7	29.2
3	Not responded	3	12.5
4	Total	24	100

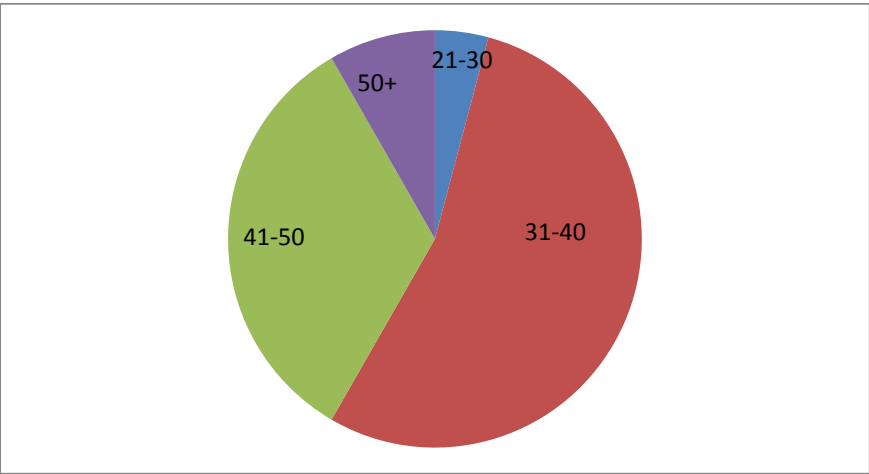


The majority of respondents (58.3%) were females and 29.2% were males. It is a normal tendency that in primary schools the majority of teachers are females.

**4.2.3.2 Age of teacher respondents**

**Table 4.8: Age of teacher respondents**

	<b>Variables</b>	<b>f</b>	<b>%</b>
1	-21	0	0
2	21-30	1	4.2
3	31-40	13	54.2
4	41-50	8	33.3
5	50+	2	8.3
	Not responded	0	0
<b>Total</b>		<b>24</b>	<b>100</b>

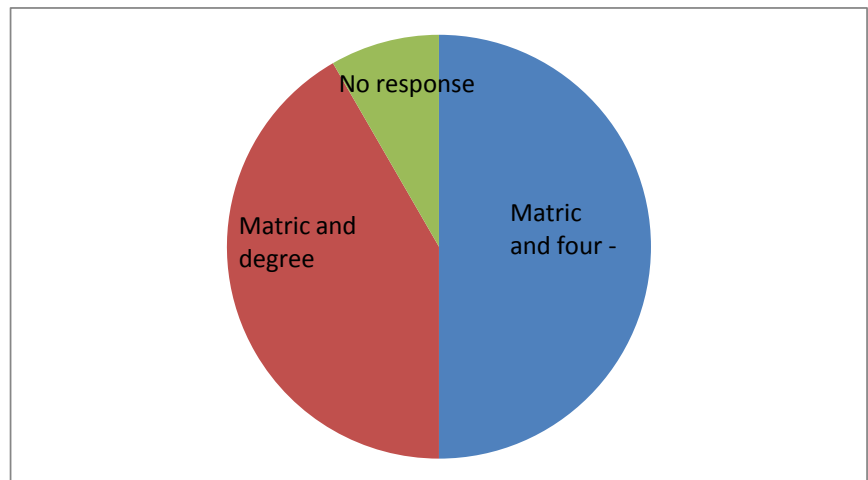


Most of the respondents (54.2%) were between the ages 31-40, 33.3% were between 41-50 yrs, 8.3% were in their 50's and above. The younger age group (21-30) comprised 4.2% of the participants.

### 4.2.3.3 Level of education of teacher respondents

**Table 4.9: Level of education of teacher respondents**

	<b>Variables</b>	<b>f</b>	<b>%</b>
1	Below matric	0	0
2	Matric	0	0
3	Matric and teaching certificate	0	0
4	Matric and four-year teaching diploma	12	50
5	Matric and degree	10	41.7
6	Not responded	2	8.3
5	Total	24	100

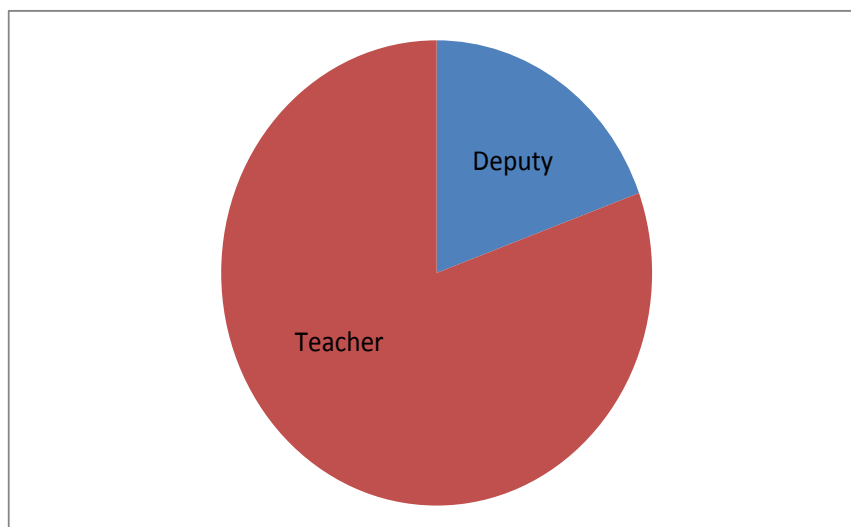


The majority of respondents (50%) had Matric and a four-year teaching diploma and 41.7% had Matric and a degree. The data indicated that most of the respondents were qualified teachers.

#### 4.2.3.4 Position of teacher respondents

**Table 4.10: Position of teacher respondents**

	<b>Variables</b>	<b>F</b>	<b>%</b>
1	Principal	0	0
2	Deputy	2	8.3
3	HOD	0	0
4	Teacher	22	91.7
5	Other	0	0
6	Not responded	0	0
7	Total	24	100

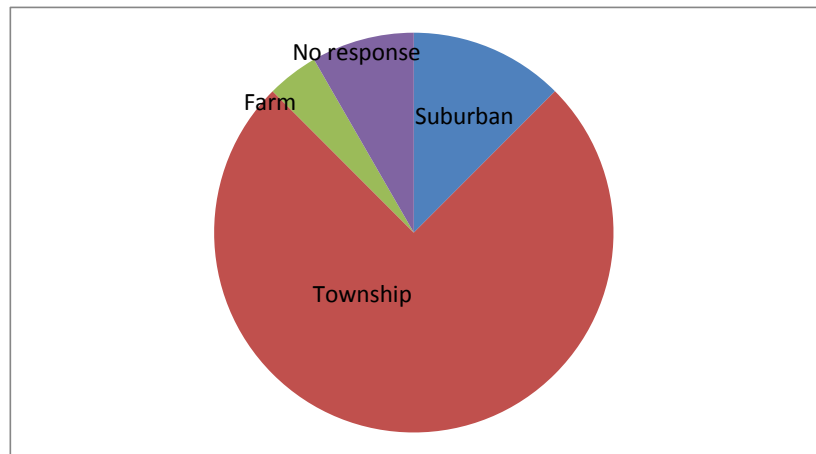


Most of the respondents (91.7%) were at post level 1, and 8.3% were deputy principals.

#### 4.2.3.5 Type of school of teacher respondents

**Table 4.11: Type of school of teacher respondents**

	Variables	F	%
1	Suburban	3	12.5
2	Township	18	75
3	Farm schools	1	4.2
4	Not responded	2	8.3
5	Total	24	100

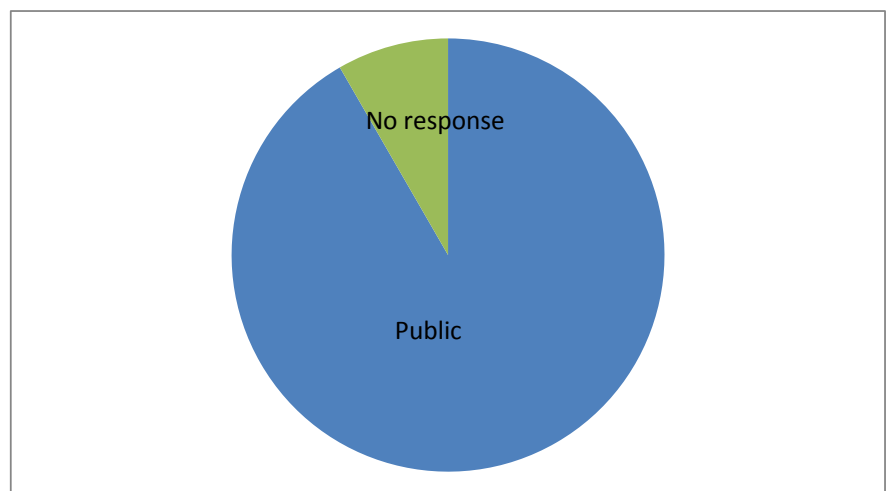


The majority of respondents (75%) taught in township schools and 4.2% were employed in farm schools.

#### 4.2.3.6 Ownership of school of the teacher respondents

**Table 4.12: Ownership of school of the teacher respondents**

	Variables	F	%
1	Public	22	91.7
2	Private	0	0
3	Not responded	2	8.3
4	Total	24	100

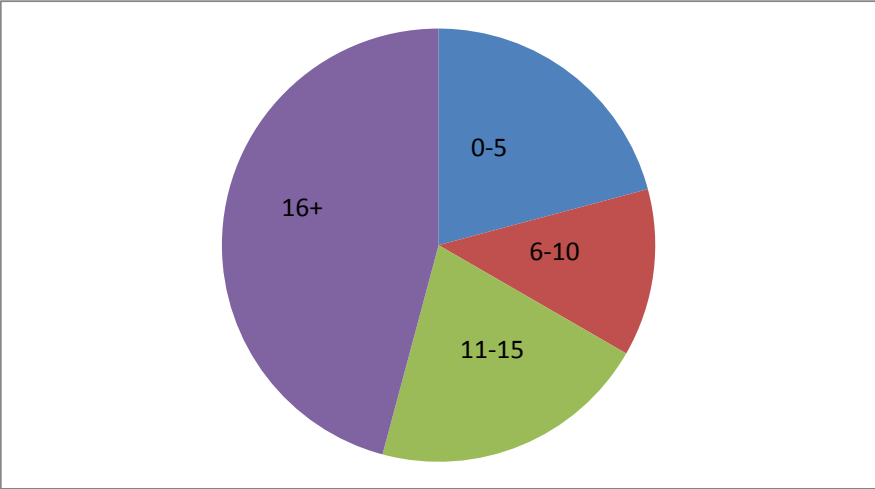


The above table indicates that the majority of respondents (91.7%) were employed in public schools.

**4.2.3.7 Experience in teaching of teacher respondents**

**Table 4.13: Experience in teaching of teacher respondents**

	<b>Variables</b>	<b>F</b>	<b>%</b>
1	0-5yrs	5	20.8
2	6-10yrs	3	12.5
3	11-15yrs	5	20.8
4	16+	11	45.8
5	Not responded	0	0
6	Total	24	100

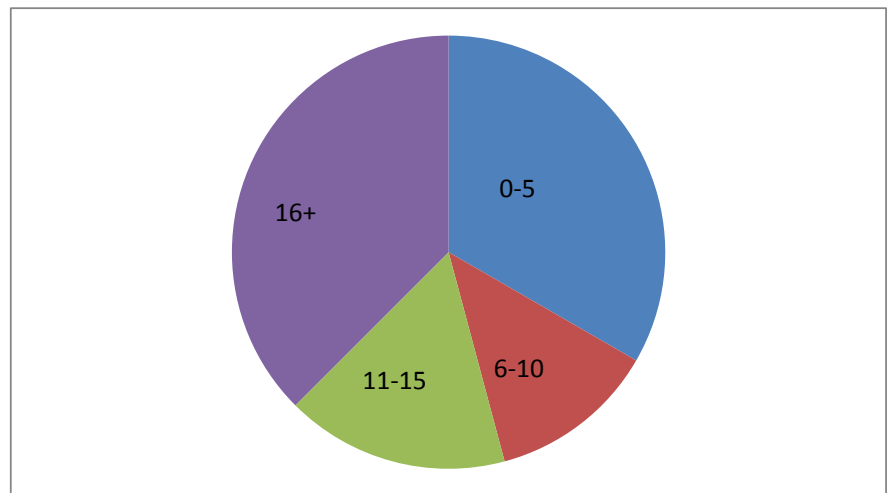


The majority of respondents (45.8%) had 16 years and more teaching experience, 20.8% had 0-5 years experience, 20.8% had 11-15 years experience and 12.5% had 6-10 years experience. The data indicated that most of the respondents were experienced teachers.

#### 4.2.3.8 Teacher respondents' experience in teaching Mathematics

**Table 4.14: Teacher respondents experience in teaching Mathematics**

	Variables	F	%
1	0-5yrs	8	33.3
2	6-10yrs	3	12.5
3	11-15yrs	4	16.7
4	16+	9	37.5
5	Not responded	0	0
6	Total	24	100



Most of the respondents (37.5%) had 16 years and more experience in teaching Mathematics, 33.3% had 0-5 years experience, 16.7% had 11-15 years, 12.5% had 6-10 years' experience.

### 4.3 DATA ANALYSIS: LEARNER AND TEACHER QUESTIONNAIRE RESPONSES

This section presents the responses obtained from both the learners and the teachers for each of the sections in the questionnaire. Each section focused on a specific construct in relation to authentic teaching and learning. The learner and teacher questionnaire focused on the same issues, questions were phrased to suit the learners and the teachers, and sections contained the same number of questions. The learners' and teachers' results are reported together in order to compare their responses. The data in the tables are presented as frequencies and percentages for each of the questionnaire statements in the various questionnaire sections.

#### **4.3.1 Learner and teacher responses: the provision of authentic teaching and learning experiences in the Mathematics classroom**

This section enquired from the learners and the teachers to indicate to what extent they agree or disagree with statements made about teachers in relation to authentic teaching and learning. The responses of the teachers to these statements (sections B1 and B2) provided the researcher with an indication of the knowledge that they possess regarding the principles of authentic teaching and learning. The learner responses to these items indicated to the researcher their opinions regarding the application of authentic teaching and learning principles in the Mathematics classroom.

The researcher wishes to emphasize the following principle that was taken into account in the interpretation of the responses in the different sections of the questionnaire. In order to provide opportunities for authentic teaching and learning, the ideal responses to the questionnaire statements would indicate that the teacher respondents “strongly agreed” or “agreed” to the questionnaire statements and that the principles of authentic teaching and learning are “almost always” and “often” applied in the classroom. **The researcher was particularly interested in the “almost always” and “strongly agree” responses as an indication that the principles of authentic teaching and learning are really translated into classroom practice on a frequent basis. It is for this reason that the “almost always” and “often” and the “strongly agree” and “agree” responses were not clustered together in the interpretation of the data. The researcher is therefore aware of the fact that the clustering of the “almost always” and “often” responses could provide a different picture of the classroom situation.**

The responses to the statements for both learners and teachers appear in Table 4.15 below.

**Table 4.15: Section B1: Authentic Teaching**

Statement	Respondents	Strongly Agree	Agree	Disagree	Strongly disagree
1. Teachers can make mistakes	Learners	120 27.3%	256 58.2%	41 9.3%	23 5.2%
	Teachers	7 29.2%	14 58.3%	3 12.5%	0 0.0%
2. Teachers should have all the answers	Learners	134 30.5%	142 32.3%	118 26.8%	45 10.4%
	Teachers	3 12.5%	4 16.7%	13 54.2%	4 16.7%
3. Teachers should have open relationships with learners.	Learners	219 49.8%	145 33.0%	45 10.2%	31 7.0%
	Teachers	17 70.8%	6 25.0%	1 4.2%	0 0.0%
4. Teachers should ask themselves if the way they teach is suitable	Learners	146 33.2%	202 45.8%	57 13.0%	35 8.0%
	Teachers	17 70.8%	6 25.0%	1 4.2%	0 0.0%
5. Teachers should see each learner as an individual in his own right.	Learners	165 37.5%	153 34.7%	72 16.4%	50 11.4%
	Teachers	14 58.3%	10 41.7%	0 0.0%	0 0.0%
6. Teachers should ask themselves if they can improve on the way they teach.	Learners	180 40.9%	168 38.2%	56 12.7%	36 8.2%
	Teachers	15 62.5%	8 33.3%	1 4.2%	0 0.0%
7. Teachers should practise what they preach.	Learners	178 40.5%	156 35.4%	71 16.1%	35 8.0%
	Teachers	16 66.7%	5 20.8%	3 12.5%	0 0.0%
8. Teachers should help learners to	Learners	243 55.2%	131 29.8%	33 7.5%	33 7.5%

develop their potential.	Teachers	20 83.3%	3 12.5%	1 4.2%	0 0.0%
9. Teachers and learners should learn together.	Learners	225 51.1%	142 32.3%	37 8.4%	36 8.2%
	Teachers	11 45.8%	10 41.7%	3 12.5%	0 0.0%
10. Teachers should try out new methods of teaching.	Learners	175 39.8%	175 39.8%	61 13.8%	29 6.6%
	Teachers	18 75.0%	5 20.8%	1 4.2%	0 0.0%
11. Teachers should tell learners what they expect of them.	Learners	191 43.4%	167 38.0%	47 10.7%	35 8.0%
	Teachers	15 62.5%	7 29.2%	2 8.3%	0 0.0%
12. Teachers should know what will help them to teach better.	Learners	232 52.8%	152 34.5%	29 6.6%	27 6.1%
	Teachers	13 54.1%	10 41.7%	1 4.2%	0 0.0%
13. A teacher should be a coach.	Learners	176 40.0%	156 35.4%	80 18.2%	28 6.4%
	Teachers	12 50.0%	11 45.8%	1 4.2%	0 0.0%
14. A teacher should be an instructor.	Learners	171 38.9%	135 30.6%	83 18.9%	51 11.6%
	Teachers	9 37.5%	9 37.5%	6 25.0%	0 0.0%
15. A teacher should provide learners with resources during teaching.	Learners	150 34.1%	166 37.7%	83 18.9%	41 9.3%
	Teachers	6 25.0%	11 45.8%	6 25.0%	1 4.2%
16. Teachers should present learners with	Learners	181 41.1%	157 35.7%	56 12.7%	46 10.5%

problems to solve during teaching.	Teachers	10 41.6%	13 54.2%	1 4.2%	0 0.0%
17. Teachers should involve all the senses of learners during teaching.	Learners	148 33.6%	219 49.8%	39 8.9%	34 7.7%
	Teachers	14 58.3%	7 29.2%	3 12.5%	0 0.0%

The majority of learners and teachers respectively agreed with 58.2% and 58.3% that teachers can make mistakes. This response supports the viewpoint of Ray and Anderson (2000:8) (*cf.* 2.3) that authentic teachers can make mistakes.

The majority of learners (32.3%) agreed and strongly agreed (30.5%) that teachers must have all the answers, whereas the majority of teachers (54.2%) disagreed that they should have all the answers. The teachers responded in line with the view of Ray and Anderson (2000:8) (*cf.* 2.3) that states that authentic teachers should admit to learners that they do not have all the answers.

The majority of learners and teachers respectively strongly agreed with 49.8% and 70.8% that teachers should have open relationships with learners. These responses support the argument of Cranton and Carusetta (2004b:7) (*cf.* 2.2) that open relationships encourage authenticity.

Learners agreed (45.8%) and strongly agreed (33.2%) that teachers should ask themselves if the way they teach is suitable. The majority of teachers strongly agreed (70.8%) that teachers should question the suitability of the way they teach. Reflecting on one's own teaching practice is an important aspect of authentic teaching (Cranton, 2006:9) (*cf.* 2.3.2), and it seems as if teachers acknowledge the importance of reflection during teaching. The response to this statement is supported by the responses obtained for item 6, where the majority of learners (40.9%) and teachers (62.5%) strongly agreed that teachers should ask themselves if they can improve on the way they teach.

Sharp (1995:48) (*cf.* 2.3) indicates that it is important to separate the individual from the group in authentic teaching. It is encouraging that the majority of learners (37.5%) as

well as teachers (58.3%) strongly agreed and agreed with 34.7% and 41.7% respectively, that the individuality of a learner is important.

Learners and teachers strongly agreed with 40.5% and 66.7% respectively that teachers should practise what they preach. Their responses are supported by Ray and Anderson (2000:8) (*cf.* 2.3) who assert that authentic teachers make sure that their behaviours and words are congruent.

The majority of learners (55.2%) and teachers (83.3%) strongly agreed that teachers should help learners to develop their potential. Jarvis (1992:113) suggests that an authentic teacher fosters the growth and development of his/her learners (*cf.* 2.3). From the responses obtained, it appears that teachers acknowledge the importance of this principle of authentic teaching.

Learners (51.1%) and teachers (45.8%) respectively strongly agreed that they should learn together, which appears to be in line with what is advocated by Jarvis (1992:114) (*cf.* 2.3), namely that teachers should learn and grow together with their learners.

With regard to whether teachers should try out new teaching methods, the majority of learners strongly agreed (39.8%) and agreed (39.8%) that teachers should try out new methods. Their responses were supported by the majority of teachers who indicated with 75.0% that they strongly agree to the statement. The literature indicates that in order to provide authentic teaching, teachers have to apply a wide variety of teaching methods, to provide experiential learning to learners (Gradgenett & Harris, 2007; Kramer, 2006:102-106; Borich, 2004:22) (*cf.* 2.4.8), and according to the teacher responses, it appears as if teachers are trying to comply with this principle of authentic teaching.

Learners and teachers strongly agreed with 43.4% and 62.5% respectively that teachers should tell learners what they expect of them. Cranton (2006:6) asserts that teachers should make public their expectations to learners (*cf.* 2.3), and it appears as if some of the teachers who took part in the study comply with this principle of authentic teaching.

It is advocated by Cranton (2006:6) (*cf.* 2.3.1), that in order for authentic teaching to take place, teachers need to know what inhibitors and enhancers to learning are

present during teaching. The majority of learners (52.8%) and teachers (54.1%) strongly agreed that teachers should know what will help them to teach better.

The majority of learners (41.1%) and teachers (54.2%) strongly agreed and agreed respectively that learners should be given problems to solve. In addition to this the majority of learners (40.0%) and teachers (50.0%) strongly agreed that the teacher needs to play the role of a coach. With regard to the role as instructor the majority of learners and teachers strongly agreed and agreed with 38.9% and 30.6% and 37.5% and 37.5% respectively, that teachers should act as instructors. In this regard, Rick (1998:3) and Gradgenett and Harris (2007:2) argue for problem-based learning to be central to authentic learning, as well as the fact that the teacher should act as a coach who helps learners develop their skills and knowledge, shaping their strategies and providing them with resources (Rick, 1998:4) (*cf.* 2.4). According to Renzulli *et al.* (2004:74) (*cf.* 2.4), the learner's role changes during authentic teaching and learning from lesson-learner to first-hand inquirer and the role of the teacher changes from instructor and disseminator of knowledge to coach, resource procurer and mentor. Regarding the statement as to whether teachers should provide resources during teaching, the majority of learners strongly agreed (37.7%) and agreed (34.1%) respectively that teachers should be responsible for resource provision during teaching and learning. The teachers appeared not to share this view, as only 25% strongly agreed to the provision of resources during teaching and learning. The majority of teachers (45.8%), agreed to the provision of resources being part of their responsibilities. The literature reveals that teachers are responsible to provide resources to enhance authentic teaching and learning as the use of resources encourage learners to explore (Epstein, 2002) (*cf.* 1.1).

The majority of learners (49.8%) agreed and the majority of teachers strongly agreed (58.3%) that teachers should involve all the senses of learners during teaching. These responses support the literature review that highlights the fact that experiential learning which involves learning *inter alia* through sensing, should characterize authentic teaching (Gradgenett & Harris, 2007:2) (*cf.* 2.4.8).

**In summary**, based on the learner and teacher responses, it appears as if many of the teachers who took part in the study have knowledge about the principles of authentic

teaching and learning as a large number of the teacher participants “strongly agreed” or “agreed” to all of the items. Only for item 2, the majority of teachers responded with “disagree”. This response was, however, in line with the literature on authentic teaching, as it is important in the context of authentic teaching that teachers should admit not having all the answers (Ray & Anderson, 2000:8) (*cf.* 2.3). It is, however, disconcerting that there are still some teachers who apparently do not apply the principles of authentic teaching, as some of the teacher responses “disagreed” and “strongly disagreed” with the principles listed in this section of the questionnaire as being tenets of authentic teaching.

The majority of the learner responses indicated that they are in favour of the principles being incorporated in their Mathematics classrooms. Only for item 2 they indicated their disagreement, and felt that teachers should have all the answers.

#### **4.3.2 Learner and teacher responses: the provision of authentic teaching and learning and assessment experiences in the Mathematics classroom**

This section enquired from the learners and the teachers to indicate to what extent they agree or disagree with statements in relation to authentic teaching, learning and assessment. The responses to the statements appear in Table 4.16 below.

**Table 4.16: Section B2: Authentic learning and assessment**

<b>Statement</b>	<b>Respondents</b>	<b>Strongly Agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
1. Learning tasks should be related to real life situations.	Learners	169 38.4%	182 41.4%	61 13.8%	28 6.4%
	Teachers	16 66.7%	8 33.3%	0 0.0%	0 0.0%
2. Learning tasks should involve exploration.	Learners	178 40.5%	180 40.9%	64 14.5%	18 4.1%
	Teachers	12 50.0%	11 45.8%	1 4.2%	0 0.0%
3. Learning tasks should involve enquiry.	Learners	140 31.8%	187 42.5%	65 14.8%	48 10.9%

	Teachers	14 58.3%	9 37.5%	1 4.2%	0 0.0%
4. Learners should solve real-life problems.	Learners	181 41.1%	148 33.6%	72 16.4%	39 8.9%
	Teachers	14 58.3%	9 37.5%	1 4.2%	0 0.0%
5. Learners should be asked to give their own opinions during teaching.	Learners	161 36.6%	147 33.4%	84 19.1%	48 10.9%
	Teachers	15 62.5%	8 33.3%	1 4.2%	0 0.0%
6. Learners should be asked to judge information.	Learners	190 43.2%	138 31.3%	80 18.2%	32 7.3%
	Teachers	7 29.2%	14 58.3%	3 12.5%	0 0.0%
7. Learners should be asked to summarize information.	Learners	139 31.6%	157 35.7%	92 20.9%	52 11.8%
	Teachers	11 45.8%	12 50.0%	1 4.2%	0 0.0%
8. Learners should be involved in conversations with teachers and peers.	Learners	142 32.3%	179 40.7%	89 20.2%	30 6.8%
	Teachers	12 50.0%	10 41.7%	2 8.3%	0 0.0%
9. Learners should be asked to separate important information from unimportant information.	Learners	136 30.8%	134 30.5%	98 22.3%	72 16.4%
	Teachers	11 45.8%	11 45.8%	1 4.2%	1 4.2%
10. Learners should have a say in what they should learn.	Learners	152 34.5%	155 35.2%	80 18.2%	53 12.1%
	Teachers	6 25.0%	12 50.0%	6 25.0%	0 0.0%
11. Learners should have a say in how things should be learned.	Learners	154 35.0%	137 31.1%	75 17.1%	74 16.8%
	Teachers	4 16.7%	8 33.3%	11 45.8%	1 4.2%

12. Learners should be able to move around in class when learning.	Learners	99 22.5%	135 30.7%	105 23.8%	101 23.0%
	Teachers	2 8.3%	10 41.7%	6 25.0%	6 25.0%
13. Learners should demonstrate what they learned.	Learners	86 19.5%	68 15.5%	93 21.1%	193 43.9%
	Teachers	11 45.8%	12 50.0%	1 4.2%	0 0.0%
14. Learners should take responsibility for their learning.	Learners	199 45.2%	169 38.4%	49 11.1%	23 5.2%
	Teachers	11 45.8%	12 50.0%	1 4.2%	0 0.0%
15. Learners should be creators of knowledge.	Learners	234 53.2%	144 32.7%	34 7.7%	28 6.4%
	Teachers	9 37.5%	14 58.3%	1 4.2%	0 0.0%
16. Learning should provide a challenge to learners	Learners	196 44.5%	180 40.9%	38 8.6%	26 5.6%
	Teachers	15 62.5%	7 29.2%	2 8.3%	0 0.0%
17. Assessment criteria should be clear to learners.	Learners	180 40.9%	169 38.4%	65 14.8%	26 5.9%
	Teachers	16 66.6%	7 29.2%	1 4.2%	0 0.0%
18. Learners should not only be expected to memorise information.	Learners	204 46.4%	162 36.8%	40 9.1%	34 7.7%
	Teachers	10 41.7%	11 45.8%	3 12.5%	0 0.0%
19. Teachers should assess learners' own views on a topic.	Learners	99 22.5%	176 40.0%	94 21.4%	71 16.1%
	Teachers	10 41.7%	12 50.0%	2 8.3%	0 0.0%
20. Teachers should not only use tests.	Learners	163 37.1%	165 37.5%	82 18.6%	30 6.8%

	Teachers	16 66.7%	6 25.0%	3 8.3%	0 0.0%
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The results revealed that the majority of learners (41.4%) and teachers (66.7%) strongly agreed that tasks should be related to real-life situations. This is supported by Renzulli *et al.* (2004:74) (*cf.* 2.4), who indicate that authentic learning implies higher-order learning that involves the application of relevant knowledge and skills to solving real-life problems.

Both learners (40.5%) and teachers (50.0%) also strongly agreed that tasks should involve exploration. Linked to this response, the majority of learners (42.5%) agreed and strongly agreed (31.8%) that learning tasks should involve inquiry. The majority of the teachers (58.3%) strongly agreed that learning tasks should also involve inquiry. Renzulli *et al.* (2004:74) (*cf.* 2.4) describes authentic learning as the vehicle through which everything from basic skills to advanced content and processes come together in the form of learner-developed product and services. The learners' role changes from lesson-learner to first-hand inquirer. Instruction should address central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understanding. Deep knowledge is a sub-criterion of disciplined inquiry which leads to in-depth understanding (Stewart & Brendefur, 2005:683) (*cf.* 2.4.2).

The data in the table also revealed that the majority of learners and teachers strongly agreed and agreed respectively to the fact that learners should solve real-life problems, give their own opinions during teaching, judge information and summarize information. The responses obtained support the literature review which argues for authentic learning to involve real-life problems (Rule & Hallagan, 2007:4) (*cf.* 2.4.8) the judging of information (Henry, 2002:67) and the development of higher-order thinking skills (Renzulli *et al.*, 2004:64) (*cf.* 2.4.1).

The majority of learners (40.7%) and teachers (50%) agreed and strongly agreed respectively that learners should be involved in conversations with teachers and peers. In the context of authentic teaching and learning the idea, is that learners should engage in extended conversational exchanges with the teacher and peers about the subject matter (Stewart & Brendefur, 2005:683) (*cf.* 2.4.4)

Analysing and synthesizing information are *inter alia* regarded as important higher-order thinking skills that should be nurtured in order to claim that authentic learning has taken place (Stewart & Brendefur, 2004:74) (*cf.* 2.4.1). The responses obtained for the statement as to whether learners should be asked to separate important information from unimportant information during teaching, indicated that more or less an equal number of learners (30.8% and 30.5%) and teachers (45.8% and 45.8%) strongly agreed and agreed to this being important. Separating important information from unimportant information requires from learners to apply the skills of analysis and synthesis in order to solve a problem (Renzulli *et al.*, 2004:74) (*cf.* 2.4).

The results for item 10 revealed that half of the teacher respondents agreed (50%) and the majority of the learner respondents (35.2%) agreed and strongly agreed (34.5%) that learners should have a say in how things should be learned. This response is in line with what Stewart and Brendefur (2005:683) (*cf.* 2.4) indicate, namely that authentic learning is characterized by learner participation in deciding what should be learned. Renzulli *et al.* (2004:74) also assert that authentic learning should *inter alia* be self-selected (*cf.* 2.4). Linked to this response, the majority of learners (35%) indicated that they should have a say in how things should be learned. Surprisingly, the majority of teachers (45.8%) disagreed with this statement. Heidegger (1962:24), as well as Fox (2001:24) (*cf.* 2.4.5), argues for critical participation and shared meaning regarding teaching and learning aspects. It appears that teachers are not yet prepared to allow learners to have a say in how they would like to learn.

Hobart (2005:12) (*cf.* 2.4) argues that authentic learning should provide learners with opportunities to act in the classroom and the world. This would apply that learners are free to move around in the classroom to engage in discussions with their peers, to invent ideas rather than accumulating facts, to manipulate objects, to do research and to investigate (Fosnot, 1989:9) (*cf.* 2.4). In response to item 12 as to whether learners should be able to move around in the classroom when teaching takes place, the majority of learners (30.7%) and teachers (41.7%) agreed to this. This implies that the teachers who took part in the study possibly provide learners with opportunities for social interaction to a certain extent which supports authentic teaching and learning (*cf.* 2.4.5). However, only 8.3% strongly agreed and 25% disagreed and strongly disagreed (25%) that learners should be allowed to move around in class during teaching. This

could imply that teachers might not yet be comfortable with the interactive nature of authentic classrooms or foresee disciplinary problems in classes with many learners (Gredler in Epstein, 2002) (*cf.* 1.1).

The majority of learners (21.1%) disagreed and strongly disagreed (43.9%) that they should demonstrate what they have learned, while 19.5% strongly agreed with this statement. It appears as if learners have divided opinions on the issue of demonstrating what they have learned. This could imply that some of the teachers provide opportunities to demonstrate what has been learned. In contrast to the learner responses, the teachers agreed (50%) and strongly agreed (45.8%) that learners should demonstrate their learning. The responses of the teachers support the view of Custer *et al.* (2000:3) (*cf.* 2.7) who argue for performance-based assessment in the context of authentic teaching and learning, as this type of assessment will allow learners to demonstrate their competence (Darling-Hammond & Snyder, 2005:528) (*cf.* 2.7.2).

Grandgenett *et al.* (2007:2) and Stewart and Brendefur, (2004:74) (*cf.* 2.4) indicate that authentic learning allows learners to get involved during learning and to construct their own knowledge by exploring, discovering, discussing and meaningfully constructing concepts and relationships in contexts that involve real-world problems. In this regard, the majority of the learners (53.2%) strongly agreed and teachers (58.3%) agreed respectively that learners should be creators of knowledge. In line with these responses, are the responses that were obtained for item 14. Once more the majority of learners (45.2%) strongly agreed to take responsibility for their own learning, where as the majority of teachers agreed (50%) that learners have to take responsibility for their own learning. In the context of authentic teaching and learning which, according to the researcher, is based on constructivist principles (*cf.* 2.4), it is disconcerting to note that not all the teachers strongly agreed to this principle. The nurturing of higher-order thinking which is central to authentic teaching and assessment requires that learners take control of their own learning (Gredler, 1997:7) (*cf.* 2.4.5).

Rick (1998:3) emphasizes the importance of authentic learning to cast learners in real-life roles to develop the knowledge and skills needed for success in school and beyond (*cf.* 2.4.7). In this regard, the majority of learners (44.5%) and teachers (62.5%) strongly agreed to this being important.

In line with the views of Guilkers *et al.* (2004:67-76) and Stiggins (2002:761) (*cf.* 2.7) who argue that in the context of authentic assessment teachers should make performance standards, outcomes and assessment criteria clear to learners, the majority of learners (40.9%) and teachers (66.6%) strongly agreed to the fact that assessment should be transparent.

In answer to the statement as to whether learners should not be expected to memorise information, the majority of learners (46.4%) strongly agreed and agreed (36.8%) that they should not be expected to memorize information only, whereas the majority of teachers (45.8%) agreed and strongly agreed (41.7%) to the statement. Although many of the teacher responses appear to be in support of the literature that indicates that authentic assessment should *inter alia* expect of learners to solve problems and think critically (Luongo-Orlando, 2003:7; Guilkers *et al.*, 2004:67-76) (*cf.* 2.7), there are still a small percentage of the teachers (12.5%) who appear to support a more traditional approach that focuses on the memorisation of information. Authentic teaching and learning however also allow the use of tests that should examine knowledge, and a firm understanding of subject content (Stewart & Brendefur, 2005:683) (*cf.* 2.4.2). Linked to the aforementioned response, the majority of learners agreed (37.5%) and strongly agreed (37.1%) that teachers should not make use of tests only. The majority of teachers supported this view by indicating with 66.7% that tests should not be the only assessment strategy that they use. This response confirms the responses obtained by the majority of teachers to item 18, namely that learners should not only be expected to memorise information.

In the context of authentic assessment, Mueller (2005:16) (*cf.* 2.7) argues that learners need to construct their own meaning of the world by using information they have gathered, information that they were taught and their own experiences with the world. This implies that they should be able to communicate their own views on topics. In response to the statement as to whether teachers should assess learners' own views on a topic, the majority of learners (40%) and teachers (50%) agreed to the statement.

**In summary**, and based on the responses obtained for the statements on authentic learning and assessment, it appears that the majority of learners strongly agreed and agreed that they support the mentioned principles of authentic teaching and learning

being part of teaching and learning in Mathematics. Problematic is the strong emphasis on memorisation of information that was noticed among many of the teacher responses. The teachers who in turn also strongly agreed and agreed to all of the statements, except statement 11 (learners should not have a say in what should be learned), apparently possess adequate knowledge to apply these principles during teaching and learning. In order to determine whether this holds true, the following section that focused on the practical application of the principles, verified the responses that were obtained from the teachers in the first two sections of the questionnaire. What remains disconcerting is the fact that there are a number of teachers who disagreed and strongly disagreed with the statements which indicated that opportunities for authentic teaching and learning are not provided in all of the classrooms that took part in the research.

#### 4.3.3 Learner and teacher responses: information on the practical application of authentic teaching and learning

This section enquired from the learners and the teachers to indicate to what extent they agree or disagree with statements made about what happens in the Mathematics classroom during teaching and learning. The responses to the statements appear in Table 4.17 below.

**Table 4.17: Section C: Practical application of authentic teaching, learning and assessment**

Statement	Respondents	Almost always	Often	Sometimes	Very seldom
1. The teachers discuss the outcomes for each lesson with the learners.	Learners	179 40.7%	130 29.5%	96 21.8%	35 8.0%
	Teachers	9 37.5%	10 41.6%	4 16.7%	1 4.2%
2. Teachers asked us to demonstrate what we have learned.	Learners	153 34.8%	149 33.9%	93 21.1%	45 10.2%
	Teachers	6 25.0%	9 37.5%	9 37.5%	0 0.0%
3. Teachers ask us to plan our	Learners	162 36.8%	118 26.8%	103 23.4%	57 13.0%

work.	Teachers	3 12.5%	7 29.1	10 41.7%	4 16.7%
4. Teachers ask us to check our own work before we submit it.	Learners	210 47.7%	113 25.7%	70 15.9%	47 10.7%
	Teachers	12 50.0%	7 29.2%	5 20.8%	0 0.0%
5. Teachers ask us to evaluate our own work.	Learners	142 32.2%	128 29.1%	120 27.3%	50 11.4%
	Teachers	6 25.0%	11 45.8%	6 25.0%	1 4.2%
6. Teachers allow us to work with our classmates.	Learners	134 30.4%	123 28.0%	144 32.7%	39 8.9%
	Teachers	8 33.3%	13 54.2%	2 8.3%	1 4.2%
7. Teachers use a variety of strategies to assess us.	Learners	146 33.2%	147 33.4%	103 23.4%	44 10.0%
	Teachers	9 37.5%	13 54.2%	2 8.3%	0 0.0%
8. Portfolios are used in class.	Learners	225 51.1%	111 25.2%	55 12.5%	49 11.2%
	Teachers	9 37.5%	8 33.3%	5 20.8%	2 8.3%
9. Testing is used as an assessment strategy.	Learners	153 34.8%	134 30.5%	97 22.0%	56 12.7%
	Teachers	9 37.5%	8 33.3%	6 25.0%	1 4.2%
10. Learners are provided with constant feedback.	Learners	150 34.1%	133 30.2%	111 25.2%	46 10.5%
	Teachers	15 62.5%	6 25.0%	3 12.5%	0 0.0%
11. The teachers provide us with more than one chance to do our work.	Learners	170 38.6%	99 22.5%	117 26.6%	54 12.3%
	Teachers	8 33.3%	11 45.8%	5 20.8%	0 0.0%

12. The teachers ask for our opinions during teaching.	Learners	154 35.0%	151 34.3%	90 20.5%	45 10.2%
	Teachers	10 41.7%	4 16.7%	8 33.3%	2 8.3%
13. My parents are informed when I experience problems.	Learners	195 44.3%	96 21.8%	100 22.7%	49 11.1%
	Teachers	10 41.7%	9 37.5%	5 20.8%	0 0.0%
14. Learners are involved in the decision-making process.	Learners	132 30.0%	126 28.6%	112 25.5%	70 15.9%
	Teachers	4 16.6%	12 50.0%	7 29.2%	1 4.2%
15. The teacher is open to new ideas.	Learners	200 45.5%	119 27.0%	83 18.9%	38 8.6%
	Teachers	15 62.5%	7 29.2%	2 8.3%	0 0.0%

The majority of the learners (40.7%) indicated that teachers almost always discuss the outcomes for each lesson with them, the majority of teachers (41.6%), in turn indicated that they often and almost always (37.5%) discuss the outcomes for lessons with the learners. In the context of enhancing authentic learning, the researcher is of the opinion that teachers should always discuss outcomes of lessons with learners. The learner and teacher responses support each other, and indicate that the discussion of outcomes for lessons does not take place on a frequent basis in all the classrooms that took part in the research. According to Newmann *et al.* (1995:13) (*cf.* 2.6), teachers should always communicate what is important to learners.

Mueller (2005:15) and Luongo-Orlando (2003:7) (*cf.* 2.7) argue that authentic assessment activities should encourage risk-taking, allow for Mathematical communication and for providing the opportunity to demonstrate the application of knowledge in unfamiliar settings. In response to item 2, the majority of the learners (34.8%) indicated that their teachers almost always ask them to demonstrate what they have learned. An equal number of teachers responded with 37.5% that they often and sometimes ask learners to demonstrate what they have learned. It is clear from the

teacher and learner responses that demonstration of what has been learned is not yet fully practised in all of the classrooms that took part in the research. This response is supported by the response obtained for item 13 in Section B1 where a low response rate was indicated for both teachers and learners regarding the use of demonstrations by learners.

Items 3, 4 and 5 focused on the involvement of learners in self-reflective activities. Authentic assessment places a greater emphasis on metacognition or self-reflection skills which involve the planning, monitoring and evaluation of the own work, than traditional assessment techniques (Luongo-Orlando, 2003:7) (*cf.* 2.7). For all three of these items, the majority of learners indicated that planning, monitoring and evaluating of work are almost always expected of them. The majority of the teachers responded that they often (29.1%) involve learners in planning, almost always (50%) involve learners in the checking of their own work, and 45.8% indicated that they often ask learners to evaluate their own work. The responses, however, also revealed that it appears that there are still many teachers who do not nurture the self-reflective skills among learners on a frequent basis, as a number of “sometimes” and “very seldom” responses were obtained from both the learners and the teachers.

Social interaction during learning is a characteristic of an authentic teaching and learning environment (Newmann *et al.*, 1995:2) (*cf.* 2.4.5). Knowledge should be constructed by learners individually and socially through an active, mental process of development (Hein 1991:1, Gray, 1997:3; Fraser, 2006:6) (*cf.* 2.4.5). The majority of the learners indicated with 30.4% that they are almost always and often (28.0%) allowed working with their peers. The teachers indicated that they often (54.2%) and almost always (33.3%) allow learners to work together. It appears that the teachers are more of the opinion that they utilize the principle of social support for learner achievement in their classrooms.

The majority of learners indicated with 33.2% and 33.4% that their teachers often and almost always use a variety of strategies to assess them. The majority of the teachers indicated with 54.2% that they often and almost always (37.5%) use a variety of assessment strategies to assess learners. These responses augur well for what the literature reveals on authentic assessment, namely that multiple forms and kinds of

assessment should be utilized to contribute to the development of the learner (Darling-Hammond & Snyder, 2005:528) (*cf.* 2.7.2). Linked to the aforementioned discussion, are the responses that were obtained for item 11. The majority of the learners (38.6%) indicated that they are almost always provided with more than one chance to do their work, and the majority of the teachers indicated with 45.8% that they often and almost always (33.8%) provide more than one chance to learners to do their work. This response links well with the argument of Darling-Hammond and Snyder (2005:528) that authentic assessment should provide a collection of assessment opportunities as evidence for success (*cf.* 2.7.3).

From the responses it appeared that portfolios are used in classrooms frequently as the majority of the learners and the teachers responded with 51.1% and 37.5% respectively that portfolio assessment is almost always used. The use of portfolios supports the principles of authentic assessment, as portfolios provide evidence of multiple opportunities that learners received to demonstrate their competence (Darling-Hammond & Snyder, 2005:528) (*cf.* 2.7.3).

The majority of the learners (34.8%), as well as the majority of the teachers (37.5%), responded that testing is almost always and often (30.5% and 33.35%) used as an assessment strategy. These responses are not completely in line with what is revealed in the literature regarding authentic assessment. According to the Department of Education (2003:17) and Suurtamm (2004:499) (*cf.* 2.7; 2.8), authentic assessment should also include alternative forms of assessment in addition to the use of tests and exams, such as performance-based or Outcomes-Based assessment. Performance-based assessment engages learners in real-world tasks and scenario-based problems. Tasks are largely open-ended and can be answered using multiple approaches. Outcomes-Based assessment looks into processes and products used. The process is assessed in order to assist and encourage learners to follow a pathway of learning and the product is assessed after a process of learning has been completed. Learners are assessed according to assessment criteria, rather than against the norm in the class (Suurtamm, 2004:499) (*cf.* 2.7).

According to Rick (1998:4), providing feedback to learners is an important component for authentic teaching and assessment. In the feedback phase, teachers create structures

within which learners can reflect on and assess their products, processes, and level of understanding (Rick, 1998:4) (*cf.* 2.4.8). The majority of the learners (34.1%) and the majority of the teachers (62.5%) indicated that feedback is provided on a constant basis. It appears however, that there are still some of the teachers who took part in the study who do not provide constant feedback to their learners and therefore obstruct the ideals of authentic teaching and assessment.

Voicing the own opinion and being involved in the decision-making process in class are highlighted in the literature as principles of authentic teaching and learning (Henry, 2002:67) (*cf.* 2.4.5). It appears as if the teachers who took part in the study to a certain extent comply with these principles as the majority of learners (35%) and teachers (41.7%) indicated that the opinions of learners are almost always called for during teaching. With regard to learners being involved in the decision-making process, the majority of the learners (30%) indicated that they are almost always involved in the decision-making process, whereas 50% of the teachers indicated that they often involve learners in the decision-making process. Although a number of teachers appear to comply with the principles of authentic teaching and learning in their classrooms, not all the teachers who took part in the study translate these principles into practice.

According to Stewart and Brendefur (2005:683) (*cf.* 2.4.2), authentic teaching and learning involves the expression of one's unique ideas and opinions. It appears that teachers are complying with this principle, as the majority of the learners (45.5%) and the majority of the teachers (62.5%) indicated that teachers are open to new ideas in the classroom. Linked to this response, the majority of the learners (35%) and teachers (41.7%) were of the opinion that learners are almost always asked for their opinions. This response supports the response received to item 5 in the previous section (*cf.* 4.3.2) where the majority of the teachers and learners indicated that they strongly agree that learners should voice their opinions.

**In summary**, this section indicated that the principles of authentic teaching and assessment have not yet fully become a reality in the classrooms that took part in the research, as there are still a number of teachers and learners who indicate that the application of the principles of authentic teaching and learning only happen often and very seldom. The responses of both the teachers and the learners do not convincingly

indicate that the classrooms in which the research was conducted fully adhere fully to the principles of authentic teaching and learning. Problematic aspects appear to be the use of discussions and the involvement of learners in self-reflective activities.

#### 4.3.4 Learner and teacher responses: teaching and assessment strategies

This section required the learners and the teachers to indicate how frequently they utilize certain teaching strategies in the Mathematics classroom. The responses to the statements appear in Table 4.18 below.

**Table 4.18: Section D1: Teaching strategies**

Statement	Respondents	Almost always	Often	Sometimes	Very seldom
1. Lectures	Learners	143 32.5%	93 21.1%	98 22.3%	106 24.1%
	Teachers	3 12.5%	2 8.3%	7 29.2%	12 50.0%
2. Drilling	Learners	126 28.6%	118 26.8%	114 25.9%	82 18.7%
	Teachers	6 25.0%	13 54.2%	3 12.5%	2 8.3%
3. Worksheets to complete	Learners	247 56.1%	90 20.5%	85 19.3%	18 4.1%
	Teachers	6 25.0%	11 45.8%	7 29.2%	0 0.0%
4. Presentation by a teacher	Learners	197 44.7%	116 26.4%	81 18.4%	46 10.5%
	Teachers	11 45.8%	12 50.0%	1 4.2%	0 0.0%
5. Demonstrations by the teacher	Learners	197 44.8%	114 25.9%	95 21.6%	34 7.7%
	Teachers	12 50.0%	11 45.8%	1 4.2%	0 0.0%
6. Presentation by a learner	Learners	149 33.8%	111 25.2%	123 28.0%	57 13.0%

	Teachers	4 16.6%	10 41.7%	10 41.7%	0 0.0%
7. Demonstration by a learner	Learners	140 31.8%	118 26.8%	119 27.1%	63 14.3%
	Teachers	4 16.6%	10 41.7%	6 25.0%	4 16.7%
8. Solving problems	Learners	189 43.0%	114 25.9%	100 22.7%	37 8.4%
	Teachers	10 41.7%	9 37.5%	3 12.5%	2 8.3%
9. Making posters	Learners	121 27.5%	116 26.3%	153 34.8%	50 11.4%
	Teachers	7 29.2%	10 41.7%	7 29.2%	0 0.0%
10. Role plays	Learners	127 28.9%	114 25.9%	133 30.2%	66 15.0%
	Teachers	3 12.5%	6 25.0%	13 54.2%	2 8.3%
11. Projects	Learners	213 48.4%	93 21.1%	111 25.2%	23 5.3%
	Teachers	5 20.8%	13 54.2%	6 25.0%	0 0.0%
12. Field trips / Excursions	Learners	99 22.5%	103 23.4%	158 35.9%	80 18.2%
	Teachers	8 33.3%	10 41.7%	6 25.0%	0 0.0%
13. Debates	Learners	122 27.7%	86 19.5%	142 32.3%	90 20.5%
	Teachers	1 4.1%	3 12.5%	16 66.7%	4 16.7%
14. Crossword puzzles	Learners	129 29.3%	104 23.6%	146 33.2%	61 13.9%
	Teachers	2 8.3%	10 41.7%	10 41.7%	2 8.3%

16. Cooperative learning (working in groups with classmates)	Learners	163 37.0%	101 23.0%	150 34.1%	26 5.9%
	Teachers	9 37.5%	10 41.6%	4 16.7%	1 4.2%
17. Brainstorming ideas	Learners	150 34.1%	111 25.2%	142 32.3%	37 8.4%
	Teachers	5 20.8%	11 45.8%	8 33.3%	0 0.0%

In this section of the questionnaire, the learners and teachers were expected to assess the frequency with which they utilize a variety of teaching strategies that represent the direct, indirect, independent and interactive methods of teaching. In the context of the study, the researcher refers to the distinction made by Kramer (2006:102-106) who highlights the importance of balancing the application of direct, indirect, independent and interactive teaching methods and their related strategies during instruction (Borich, 2004:22; Eggen & Kauchak, 2010:419) (*cf.* 2.4.8).

From the responses it became clear that although teachers do utilize a variety of teaching strategies during teaching, a number of learners and teachers indicated that some of these strategies are only utilized sometimes or very seldom. The most popular strategies according to the learners appeared to be the **completion of worksheets, presentations by the teachers, demonstrations by the teachers, solving problems and doing projects**. It is interesting to note that the majority of the learners (32.5%) indicated that they are almost always and often (21.1%) lectured to, whereas 29.2% of the teachers indicated that this only happens sometimes and very seldom (50%). Learners and teachers appear not to be in accord regarding the utilization of lecturing in the classroom. In the context of authentic teaching and learning, lecturing is not regarded as a conducive strategy to develop higher-order thinking skills that characterize an authentic learning environment as it does not allow for construction of knowledge (Stewart & Brendefur, 2005:683) (*cf.* 2.4.1).

For all of the statements in this section of the questionnaire it appeared that the learners were more of the opinion than the teachers that the various teaching strategies are utilized on an “almost always” basis, as a tendency was noted that the majority of all the

learner responses indicated that the strategies were employed on an almost always basis, except for the use of **field trips, making posters, role plays, crossword puzzles** and **debates**. According to the learner responses, the following teaching strategies appeared to be under-utilized: **cooperative learning, brainstorming** and **presentations** and **demonstrations by learners**. In contrast to the learner responses, the majority of the teacher responses inclined to the often responses as an indication for the frequency with which a variety of teaching strategies were used. The teaching strategies used most frequently according to the teacher responses were: **drilling, presentations by the teacher, demonstrations by the teacher** and **problem-solving**. **Role plays** and **debates** appeared to be under-utilized. It is clear from the responses obtained, that experiential learning which is based on the utilization of a variety of teaching strategies to make learners experience, observe, reflect, think and act during teaching and learning, does not yet characterize the classrooms on which the research focused (Grosser, 2002:11) (cf. 2.4.8). It appears that lecturing and drilling have prominence in the classrooms that took part in the research.

#### 4.3.5 Learner and teacher responses: assessment strategies

This section required the learners and the teachers to indicate to what extent they agree or disagree with statements made about how often they utilize the assessment strategies in the Mathematics classroom. The responses to the statements appear in Table 4.19 below

**Table 4.19: Section D2: Assessment tasks**

Statement	Respondents	Almost always	Often	Sometimes	Very seldom
18. To summarize information	Learners	170 38.6%	121 27.5%	119 27.1%	30 6.8%
	Teachers	4 16.7%	13 54.2%	6 25.0%	1 4.2%
19. To give our own opinion	Learners	164 37.3%	118 26.8%	110 25%	48 10.9%
	Teachers	10 41.7%	10 41.7%	3 12.5%	1 4.1%

20. To compare things	Learners	164 37.3%	113 25.7%	118 26.8%	45 10.2%
	Teachers	8 33.3%	9 37.5%	7 29.2%	0 0.0%
21. To judge information	Learners	116 26.4%	121 27.5%	127 28.9%	76 17.2%
	Teachers	5 20.8%	11 45.8%	8 33.3%	0 0.0%
22. To indicate to the important facts in a piece of work	Learners	166 37.7%	121 27.5%	104 23.7%	49 11.1%
	Teachers	6 25.0%	13 54.2%	3 12.5%	2 8.3%
23. To indicate the unimportant facts in a piece of work	Learners	111 25.3%	119 27.0%	139 31.6%	71 16.1%
	Teachers	5 20.8%	9 37.5%	4 16.7%	6 25.0%
24. Providing precise-to-the-point information	Learners	149 33.9%	98 22.3%	130 29.5%	63 14.3%
	Teachers	6 25.0%	14 58.3%	4 16.7%	0 0.0%
25. Discovering and exploring	Learners	169 38.4%	115 26.1%	109 24.8%	47 10.7%
	Teachers	7 29.1%	10 41.7%	6 25.0%	1 4.2%
26. Experimenting	Learners	127 28.9%	122 27.7%	132 30.0%	59 13.4%
	Teachers	4 16.7%	12 50.0%	3 12.5%	5 20.8%
27. Group discussion	Learners	197 44.7%	94 21.4%	121 27.5%	28 6.4%
	Teachers	6 25.0%	12 50.0%	6 25.0%	0 0.0%
28. Research projects	Learners	183 41.6%	121 27.5%	99 22.5%	37 8.4%

	Teachers	7 29.2%	4 16.7%	11 45.8%	2 8.3%
29. Investigation	Learners	167 38.0%	116 26.4%	119 27.0%	38 8.6%
	Teachers	6 25.0%	12 50.0%	6 25.0%	0 0.0%
30. Assignments	Learners	204 46.3%	123 28.0%	92 20.9%	21 4.8%
	Teachers	3 12.5%	9 37.5%	5 20.8%	7 29.2%
31. Tests / Exams	Learners	239 54.4%	93 21.1%	88 20.0%	20 4.5%
	Teachers	8 33.3%	11 45.9%	5 20.8%	0 0.0%
32. Presentation in class	Learners	175 39.7%	123 28.0%	102 23.2%	40 9.1%
	Teachers	8 33.3%	13 54.2%	3 12.5%	0 0.0%
33. Translation tasks: Diagrams, mind maps	Learners	176 40.0%	88 20.0%	130 29.5%	46 10.5%
	Teachers	5 20.8%	9 37.5%	9 37.5%	1 4.2%

In this section of the questionnaire, the learners and teachers were expected to assess the frequency with which they utilize a variety of assessment strategies. Authentic assessment places greater emphasis on problem-solving, critical thinking, comprehension, reasoning and metacognition or self-reflection skills than on traditional assessment techniques which involve tests and exams. The formats for learner work recognize learners' multiple intelligences, different learning styles and varying developmental levels (Luongo-Orlando, 2003:7) (*cf.* 2.7).

According to the learner responses, the most frequently used assessment strategies by their teachers, based on the clustering of the almost always and often responses appeared to be **tests and exams** (75.5%), **assignments** (74.3%), **research projects**

(69.1%) , **group discussions** (66.1%)and **providing precise-to-the-point information** (56.2%).

In contrast to these responses the majority of the teachers indicated that they often utilize **providing precise to the point information** (58.3%), **presentations in class** (54.2%), **identifying important facts in work** (54.2%), **summarizing information** (54.2%), **experimenting** (50%), **group discussions** (50%) and **investigation** (50%). The researcher is concerned that the emphasis on tests and exams, as highlighted by the learner responses, as well as providing precise information, indicated by the teachers and the learners, appear to be utilized in favour of some of the other assessment strategies that are more apposite for nurturing higher-order thinking skills such as problem-solving, judging, comparing, reasoning and critical comprehension (Guilkers *et al.*, 2004:67-76) (*cf.* 2.4.1; 2.7).

In the next section, a comparison between the learner and teacher responses for the various sections of the questionnaire will be explored.

#### **4.4 COMPARISON: LEARNER AND TEACHER RESPONSES TO THE QUESTIONNAIRE**

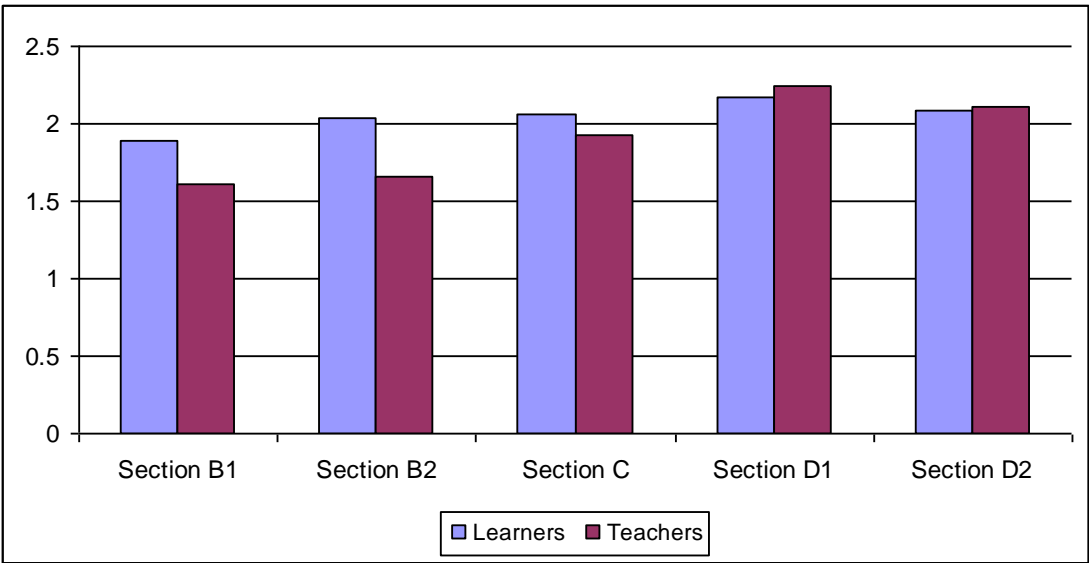
In order to determine whether the differences that were noted in the previous section between the learner and teacher responses were statistically significant, the responses obtained for the different questionnaire sections were compared. Averages were calculated for the various responses obtained for the sections of the questionnaire. Table 4.20 indicates the average results obtained for the comparison of the learner and teacher responses respectively.

**Table 4.20: Comparison: Learner and teacher responses to the questionnaire sections**

Questionnaire section	Authentic teaching B1	Authentic learning B2	Practical application C1	Teaching strategies D1	Assessment strategies D2
	B1 (1-17) Average	B2 (1-20) Average	C (1-15) Average	D1 (1-17) Average	D2 (18-33) Average
Learners	1.89	2.03	2.06	2.16	2.08
Teachers	1.60	1.66	1.92	2.24	2.11

Figure 4.1 provides a graphical representation of the results indicated in Table 4.21.

**Figure 4.1: Comparison: averages for the learner and teacher responses**



In interpreting the results, it is important to note that the lower the mean, the more favourable the response, as it is closer to 1. In the context of the study the **strongly agree** and **almost always** responses were regarded as the more favourable responses (cf. 4.3.1). For all the sections in the questionnaire it was important for the researcher that the respondents had to respond with “strongly agree” or “almost always” responses in order to indicate understanding of the principles of authentic teaching and learning

(teachers) and their translation into teaching practice in the Mathematics classroom. The responses to section B indicated that teachers to a certain extent understand the principles of authentic teaching and learning. The learners on the other hand provided positive responses to indicate their support for the application of authentic teaching and learning principles in the Mathematics classroom.

The responses obtained for section C highlighted the fact that the teachers appeared to be more convinced than the learners that their classroom teaching, learning and assessment practices complied with the principles of being authentic.

With regard to the practical application of authentic teaching, learning and assessment (sections D1 and D2) the learners were more of the opinion than the teachers that the application of teaching and assessment strategies supports the principles of authentic teaching, learning and assessment.

In order to determine whether the differences between the learner and the teacher responses as indicated by the averages reported in Table 4.21 were statistically significant, the mean scores for each of the questionnaire sections were compared. T-tests were utilized to determine whether differences that occurred were statistically significant (Pietersen & Maree, 2007d:230). To determine the effect of size differences that were statistically significant, Cohen's *d* was calculated and the effect sizes were interpreted as follows:

- 0.2: small effect size
- 0.5: medium effect size
- 0.8: large effect size (Steyn, 2005:20)

Table 4.21 reports the means, standard deviations and statistical significance of the differences between the means and the effect of the differences in practice for the learner and teacher responses for the various sections of the questionnaire. The means obtained for section B were not compared, as the researcher's aim with the questions was different for the learners and the teachers. The responses obtained from the teachers indicated the extent, to which they possess knowledge regarding authentic teaching and learning. The learner responses on the other hand, indicated the extent to which they supported the principles of authentic teaching and learning being part of teaching and learning in the Mathematics classroom.

**Table 4.21: Statistical significance of differences between learner and teacher responses**

		<b>N</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Std. Error Mean</b>	<b>F</b>	<b>t</b>	<b>Sig p</b>	<b>Cohen's d</b>	<b>Effect in practice</b>
Section C Practical application	Learners	440	2.06	.54	.02	1.67	1.26	.206	-	-
	Teachers	24	1.92	.45	.09		1.48			
Section D1 Teaching methods	Learners	440	2.16	.46	.02	2.06	-.78	.435	-	-
	Teachers	24	2.24	.35	.07		-1.00			
Section D2 Assessment strategies	Learners	440	2.08	.52	.02	.03	-.24	.805	-	-
	Teachers	24	2.11	.53	.10		1.24			

\* Significance:  $p < 0.05$

The researcher acknowledges that the teacher group was very small in comparison to the learner group, and also did not have 30 or more participants. However, according to the Statistical Consultation Services the results in both groups indicated a normal distribution, and therefore the t-test was utilized (Pietersen & Maree, 2007d:226).

It is clear from the data in the table, that there were no statistical significant differences between the responses of the teachers and learners regarding the principles that guide the practical application of authentic teaching, learning and assessment, as well as the utilization of teaching and assessment strategies in the classroom. As no statistical significant differences were noted, Cohen's *d* was not calculated. The standard deviations also revealed that there was not a large variance between the learner and teacher responses, and that the results were indeed comparable.

In order to confirm the results obtained by the questionnaire, observations were utilized. The data analysis and interpretation of the observation data follow in the next section.

#### **4.5 OBSERVATION DATA ANALYSIS AND INTERPRETATION**

After each of the observation sessions, the researcher and the co-observer compared their observation tally tables for the frequency with which the indicated principles of authentic teaching and assessment were applied during each of the 5-minute interval periods within the 60 minute observation sessions (*cf.* 3.6.2.6). After all the observations had been conducted, a joint tally table was compiled for each of the sections in the observation schedule to provide a summary of the teaching and learning situations that were observed in the six classrooms as the researcher and the co-observer determined fairly similar teaching practices across Grades 4, 5 and 6 as well as among the six teachers who were observed. Therefore, a general picture of the teaching and learning situations in the Mathematics classrooms and the trends that were observed are provided as no unique application of authentic teaching and learning principles by individual teachers were observed.

- In order to guide the researcher and co-observer in interpreting their tally scores, the following guideline was set after the pilot study was conducted.

- More than 6 tally marks allocated during an observation session implied that the specific principle was applied on a very frequent (“almost always”) basis.
- If 5 or 6 tally marks were allocated during an observation session, it implied that the specific principle was applied “often”.
- If 3 or 4 tally marks allocated during an observation session, it implied that the specific principle was applied “sometimes”.
- If 1 or 2 tally marks allocated during an observation session, it implied that the specific principle was applied “very seldom”.

The tables that follow below provide a summary of the overall observation results for all the observations made for each of the sections of the observation schedule for all six the teachers. Reflective comments are also provided to provide some detail that guided the researcher and the co-observer respectively, in finalizing their decisions regarding the frequency with which the principles of authentic teaching, learning and assessment were applied.

Table 4.22 summarizes the observation results for the criteria related to authentic teaching as observed by the researcher and the co-observer

**Table: 4.22: Observation results: authentic teaching**

<b>Criteria</b>	<b>Observation</b>	<b>Reflective comments</b>
1. Teacher has open relationships with learners.	Almost always	<p>Researcher: Learners are free, the teachers know them by name, the environment is homely and warm, they have discussions with the teachers, they are free to ask questions; teachers move around, checking and talking to learners as they work</p> <p>Co-observer: The teachers build learners' confidence by allowing most of them to answer, know all learners by their names, teachers have good teaching strategies; learners discuss issues among themselves, they share daily news with teachers, teachers accept learners' opinions; learning environment is conducive to success, teachers guide throughout the lesson.</p>
2. Learning focuses on giving knowledge.	Almost always	<p>Researcher: terminology is explained to learners, teachers provide the aim of lessons, and thoroughly explain concepts by means of examples.</p> <p>Co-observer: Concepts are explained, discussion of learners' solutions to problems.</p>
3. Learning focuses on equipping learners with skills.	Almost always	<p>Researcher: Learners are always encouraged, and emphasized when giving aims of lesson, learners were given chance to do things, teacher reinforces skills already gained.</p> <p>Co-observer: The teacher identifies learners' needs and encourages learners to work together; let learners assist each other and share ideas, learners are allowed to work independently</p>
4. Teacher has discussion about pre-knowledge of learners.	Almost always	<p>Researcher: Learners are asked questions before lessons start, learners are allowed to talk about what they know, and teachers do baseline assessment to build the new lesson on, teachers use discussions to introduce new lessons.</p> <p>Co-observer: teachers introduce new concepts as part of the introduction to a lesson.</p>
5. Teacher uses more than one method during teaching.	Almost always	<p>Researcher: Explanation is done in different ways, for better understanding, to reach those who need support, to be able to reach and cater for all learners in lesson. Question and answer used frequently as well as demonstrations with teaching aids.</p>

		Co-observer: teachers provide additional support, for better understanding, to cater for all learners. Group work is given; teachers move to groups and do explanations.
6. Teacher coaches learners during teaching.	Almost always	<p>Researcher: The teacher tries to engage all learners, to encourage them, and to help learners as they give answers, and motivate them as they work, teachers try to maintain everyone's attention, emphasizes new material learned.</p> <p>Co-observer: teachers help in getting learners involved, to motivate them and let them compete, help learners to give their own opinion; motivate learners and encourage them to give answers.</p>
7. Teacher facilitates learners during teaching	Often	<p>Researcher: The teachers walk around as learners work and help sometimes.</p> <p>Co-observer: Teachers help learner find answers on their own, the teachers provide examples.</p>
8. Teacher provides resources during teaching	Very seldom	<p>Researcher: In most cases the teacher gives learners textbooks to work with and counters and abacus are used in some lessons.</p> <p>Co-observer: Teachers always had resources such as counters, but use textbooks mostly.</p>

The literature review strongly emphasizes that, for authenticity to be fostered, there should be strong relationships between teachers and learners (Cranton & Carusetta, 2004b:7) (*cf.* 2.2). The frequency shows there are almost always open relationships between teachers and learners. Furthermore, it appears that teachers apply the principles of authentic teaching, such as equipping learners with skills (Rick, 1998:2), discussing pre-knowledge (Stewart & Brendefur, 2005:683; Henry, 2002:68), using more than one teaching strategy (Kramer, 2006:102-106), acting as coach and facilitator (Renzulli *et al.*, 2004:74). The provision of resources to learners appeared to be a problematic issue (Renzulli *et al.*, 2004:74) (*cf.* 2.3; 2.4).

Table 4.23 summarizes the observation results for the criteria related to authentic learning and assessment, as observed by the researcher and the co-observer.

**Table 4.23: Authentic learning and assessment**

<b>Criteria</b>	<b>Observation</b>	<b>Reflective comments</b>
1. Learners solve problems.	Almost always	Researcher: Learners are always given tasks to perform, solve problems in class, learners involved in activities where they have to demonstrate their understanding. Co-observer: problem-solving given on a daily basis as class work and homework.
2. Learning tasks relate to real life situations.	Sometimes	Researcher: The teacher uses examples related to daily issues and situations for better understanding and to cater for all learners. It makes the lesson easier to understand and make Mathematics real and part of daily life. Co-observer: Utilized to enhance understanding and developing learner's interest, to makes tasks simpler.
3. Learners involved in discussion with teacher and peers	Almost always	Researcher: Learners allowed working in groups, they share opinions, learners are able to discuss among themselves and with the teachers. Co-observer: Learners encouraged to share opinions and ideas, open discussions in classrooms; good relationships among learners.
4. Assessment criteria are clear to learners.	Almost always	Researcher: The teacher states it clearly during activities, it encourages good results, it guides them to achieve as they work, and learners know exactly what to do as it gives clear direction of what is expected. Co-observer: It guides learners to be able to achieve better, it prepares them thoroughly, it helps the teacher to see where support is needed, and it improves the results.
5. Teacher not only uses tests to assess learners.	Almost always	Researcher: Teachers used different forms of assessment, helps to cater for all learners, it improves learners' performance. Co-observer: It helps to balance learners' abilities, learners exposed to several forms, all levels are catered for.

It is also apparent that authentic learning and assessment enjoy prominence during teaching and learning, as all the observations revealed that the teachers who were observed very frequently apply the following principles of authentic learning and assessment: learners solving problems (Renzulli *et al.*, 2004:74) (*cf.* 2.4), allowing learners to discuss work with their peers (Stewart & Brendefur, 2005:683) (*cf.* 2.4.2), providing clear assessment criteria (Cranton, 2006:9; Guilkers *et al.*, 2004:67-76) and utilizing other assessment strategies in addition to tests (Guilkers *et al.*, 2004:67-76; Luongo-Orlando, 2003:7) (*cf.* 2.4; 2.7). However, the provision of tasks related to real life experiences (Stewart & Brendefur, 2005:683) (*cf.* 2.4.3) were not applied effectively.

Table 4.24 summarizes the observation results for the criteria related to the practical application of authentic teaching, learning and assessment as observed by the researcher and the co-observer.

**Table 4.24: Practical application of authentic teaching and assessment**

<b>Criteria</b>	<b>Observation</b>	<b>Reflective comments</b>
1. The teacher makes learners aware of the outcomes of the lesson.	Almost always	Researcher: outcomes are clearly stated, learners pay attention. Co-observer: It is done towards the conclusion of lesson, it makes them aware of the purpose of lesson, it gives learners direction, sometimes used as an introduction to lessons.
2. Teacher allows learners to work with peers/classmates.	Sometimes	Researcher: Not always, depending on the activity, sometimes used for learners to assist each other or learners helping each other. Co-observer: To assist each other and share ideas, for additional work, used to foster good relations. Not always used.
3. Teacher allows for learner's opinions during teaching.	Sometimes	Researcher: Teachers make use of questioning to obtain learners' opinions, learners are asked to motivate their answers. Co-observer: Learners are asked questions to determine their understanding, mainly used at the end of lessons, learners are motivated to ask questions to raise their concerns, when learners give explanations they are asked to motivate their answers.
4. Learners are involved in decision-making.	Sometimes	Researcher: In discussion with teacher, when given an opportunity (eg. Learners individually explain their methods to solve problems) Co-observer: Learners were sometimes allowed to decide on how they want to solve problems.
5. Learners demonstrate what they have learned.	Very seldom	Researcher: When they bring books for marking, do sums on the board, compare their answers, to show their understanding when asked questions during lessons. No performance-based assessment observed. Co-observer: To show their understanding, by doing class and home activities, doing corrections on the board, when discussing with peers at the end of the lesson, they compare their answers. No performance-based assessment applied.

6. Learners are allowed to evaluate their own work and the work of their peers.	Sometimes	<p>Researcher: Only informal assessment, but the teacher encouraged it and checked the assessments afterwards, learners given a chance to identify their mistakes.</p> <p>Co-observer: They evaluate only the informal tasks and activities, the teacher checks it afterwards. Learners' encouraged to spot their own mistakes</p>
7. Meaning is negotiated between teacher and learners	Sometimes	<p>Researcher: The emphasis is on giving knowledge. Learners assisted with misconceptions - teachers move around in classroom and have discussions with learners at their desks.</p> <p>Co-observer: Learners often asked to clarify concepts the way they understand it. Teachers mainly transmitted knowledge.</p>

The practical application of the principles of authentic teaching and assessment revealed that making learners aware of the outcomes of instruction frequently characterized the teaching and learning situations which were observed (Robertson & Fluck, 2002; Stewart & Brendefur, 2005:683; Cranton, 2006:6) (*cf.* 2.3; 2.4). It was clear that aspects such as learners working with their peers, learners voicing their opinions, learners demonstrating what they have learned, learners being involved in negotiating meaning, learners being involved in decision-making and learners evaluation their own work and the work of their peers were underscored. The latter activities are also important to establish authentic teaching and assessment in the classroom (Kraft & Billig, 1997:6; Gredler, 2002:7; Suurtamm, 2004:499) (*cf.*2.7).

Table 4.25 summarizes the observation results for the criteria related to the practical application of teaching strategies as observed by the researcher and the co-observer.

**Table 4.25: The application of teaching strategies**

<b>Criteria</b>	<b>Observation</b>	<b>Reflective comments</b>
1. Presentation and demonstration by the teacher	Almost always	Researcher: Most lessons were teacher-centered, and focused on transmitting new content Co-observer: Mainly focused on clarifying concepts to learners.
2. Presentation and demonstration by the learner	Sometimes	Researcher: Sometimes learners were requested to demonstrate to others to show their understanding – using an abacus to demonstrate place values of numbers. Co-observer: Little chance given to few learners – sometimes learners were requested to explain their understanding of a topic to the rest of the class,
3. Using co-operative learning	Very seldom	Researcher: Not used at all. Only group work used where certain learners had to assist those who were struggling. Teachers monitor and help. It is used to encourage team-work. Co-observer: No co-operative learning used. Group activities were mainly used. Learners asked to share ideas or opinions in groups.
4. Brainstorming ideas	Often	Researcher: The teacher facilitates it through questions and answers. Sometimes it is done by giving more clarity and bringing all on board. It is encouraged among the groups as they work in their groups. Sometimes used for better understanding of learners and to emphasize or clarify the question or guide to simplify task. Co-observer: Not always done, but sometimes at the beginning of the lesson. Also used to check understanding before concluding the lesson.
5. Learners given worksheet to complete	Often	Researcher: Not used frequently. The teachers used a variety of methods. Sometimes learners were encouraged to copy work from the board. Textbooks were mainly used in the classrooms. Often used for expanded opportunities and remedial activities. Co-observer: Used mostly for the completion of formal activities.

6. Other methods used	Often	<p>Researcher: Variety used to accommodate all learners. Teacher mainly used the question and answer method, demonstrations and explanations.</p> <p>Co-observer: A variety of methods used for formal tasks and activities. Teachers mainly made use of presentations and sometimes allowed students to investigate on their own.</p>
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The application of teaching strategies revealed a strong tendency for teachers to utilize presentations, whereas other strategies such as brainstorming and completing worksheets were utilized often. Presentations by learners were used sometimes and cooperative learning very seldom. The observations did not provide conclusive evidence that convinced the researcher that teachers are complying with the principles of authentic teaching, as teaching strategies that nurture higher-order thinking appear to be under-utilized in the classrooms of the teachers who took part in the study, due to the strong focus on transmission of knowledge. Authentic teaching should involve problem-based learning (Rick, 1998:3 (*cf.* 2.4.6) and opportunities for learners to explore, discover, discuss and meaningfully construct knowledge, individually and socially (Fox, 2001:24; Renzulli *et al.*, 2004:74; Hobart, 2005:12) (*cf.*2.4). It is clear from the observations that teachers still mainly rely on direct teaching methods during teaching and learning.

Table 4.26 summarizes the observation results for the criteria related to the practical application of assessment strategies as observed by the researcher and the co-observer.

**Table 4.26: Assessment strategies**

<b>Criteria</b>	<b>Observation</b>	<b>Reflective comments</b>
1. Learners summarize information	Sometimes	<p>Researcher: Usually done when concluding a lesson – however, the teachers summarized not the learners. Sometimes done in groups at the end of lessons to check on the understanding of learners. In these instances learners were involved in making summaries.</p> <p>Co-observer: To show understanding of concepts when concluding a lesson guided by the teacher. Done as feedback on the content covered during the lesson. Teachers mainly do the summarizing.</p>
2. Comparing things	Often	<p>Researcher: The teacher guides learners at the end of lesson to check understanding of lesson learnt. Also used when doing corrections in class. Also used to clarify misconceptions.</p> <p>Co-observer: used to check level of understanding. Teacher encourages learners to engage in activities.</p>
3. Learners giving their own opinion	Almost always	<p>Researcher: Always encouraged and serves as feedback on the level of understanding, it also helps as it enforces discussion among learners.</p> <p>Co-observer: Always encouraged by teacher as it gives feedback on level of understanding and enforces discussion.</p>
4. Presenting in class	Almost always	<p>Researcher: It is always encourages and they do it in turns. Shows understanding and others benefit from their peers.</p> <p>Co-observer: Done in forms of correction and learners are able to explain how they did the sum. Shows understanding and helps others to understand</p>
5. Translation tasks given	Often	<p>Researcher: Not always, it depends on the different activities planned, used to draw learners attention, to explain concepts and emphasize what is to be learned</p> <p>Co-observer: Not done always, but learners enjoy as it is more practical. Used mostly as</p>

		form of assessment. Used to emphasize on concepts. Draw learners' attention.
6. High-order thinking is assessed	Sometimes	<p>Researcher: Not always, mostly used for expanded opportunities for those learners who finish their work before the others.</p> <p>Co-observer: Not always, mostly used for high achievers. Teachers seldom cater for slow learners.</p>
7. Other assessment strategies used e.g. homework	Often	<p>Researcher: Different forms of assessments used. Homework always given to follow-up on what was done in class. Mainly projects and assignments were given to learners.</p> <p>Co-observer: Sometimes assessment was conducted as indicated in the policy. Mainly assignments given and projects that allowed investigation.</p>

From the observations obtained for the frequency with which the principles for authentic assessment are applied, the following results were revealed. It was encouraging to observe that learners were given opportunities most of the time to voice their own opinions and to do presentations in class. However, not many opportunities were provided for the assessment of higher-order thinking which is regarded as an important outcome of authentic learning and assessment (Renzulli *et al.*, 2004:74; Guilkers *et al.*, 2004:67-76) (*cf.* 2.4; 2.7).

## **4.6 TRIANGULATION OF THE DATA OBTAINED FROM THE QUESTIONNAIRES AND THE OBSERVATIONS**

### **4.6.1 Section B1: Authentic teaching**

Based on the learner and teacher responses obtained for the questionnaire, it appears as if many of the teachers who took part in the study have a fair amount of knowledge about the principles of authentic teaching and learning as a large number of the teacher participants “strongly agreed” or “agreed” to all of the items. However, there are still some teachers who apparently do not apply the principles of authentic teaching, as some of the teacher responses “disagreed” and “strongly disagreed” with the principles listed in this section of the questionnaire as being characteristics of authentic teaching (*cf.* 4.3.1). The data obtained for the observations supported the questionnaire responses, as the observations revealed that teachers apply the principles of authentic teaching, such as equipping learners with skills, discussing pre-knowledge, using more than one teaching strategy and acting as coach. The observations revealed that more attention could be paid to teachers acting as facilitators and the provision of resources to learners during teaching and learning. The questionnaire responses also indicated that more attention needs to be paid to the provision of resources during teaching and learning (*cf.* 4.3.1).

### **4.6.2 Section B2: Authentic learning and assessment**

According to the responses obtained for the statements on authentic learning and assessment, it also seems that the teachers who took part in the study possess adequate knowledge to apply these principles during learning and assessment (*cf.* 4.3.2). The data obtained for the observations supported the data obtained from the questionnaires. All the observations revealed that the teachers who were observed very frequently apply the following principles of authentic learning and assessment: learners solving problems (Renzulli *et al.*, 2004:74), allowing learners to discuss work with their peers (Stewart & Brendefur, 2005:683) providing clear assessment criteria (Cranton, 2006:9;

Guilkers *et al.*, 2004:67-76) and utilizing other assessment strategies in addition to tests (Guilkers *et al.*, 2004:67-76; Luongo-Orlando, 2003:7) (*cf.* 2.4; 2.7). What appeared to be problematic from the observations was relating teaching to real-life experiences (*cf.* Table 4.23), which supports the low response rate obtained for the use of real-life experiences in the learner questionnaire (*cf.* Table 4.16).

#### **4.6.3 Section C: Practical application of authentic teaching and assessment principles**

This section indicated that the principles of authentic teaching and assessment have not yet fully become a reality in the classrooms that took part in the research. The questionnaire responses revealed that a number of teachers and learners indicated that the application of the principles of authentic teaching and learning only happen often and very seldom. The responses of both the teachers and the learners do not convince the researcher that the principles of authentic teaching and learning are fully adhered to in the classrooms that took part in the research (*cf.* 4.3.3). This could possibly be attributed to a lack of knowledge regarding how to provide authentic learning experiences in the context of Mathematics teaching. The observations revealed that teachers frequently made learners aware of the outcomes of instruction, but in line with the responses obtained for the questionnaire, aspects such as learners working with their peers, learners voicing their opinions, learners demonstrating what they have learned, learners being involved in negotiating meaning, learners being involved in decision-making and learners evaluation their own work and the work of their peers, were underemphasized.

#### **4.6.4 Section D1: The application of teaching strategies**

From the responses to the questionnaire items the most popular strategies utilized by the teachers, according to the learners, appeared to be the **completion of worksheets, presentations by the teachers, demonstrations by the teachers, solving problems and doing projects.**

Learners appeared to be more of the opinion than the teachers that the various teaching strategies are utilized on an “almost always” basis, except for the use of **field trips, making posters, role plays, crossword puzzles** and **debates**. According to the learner responses, the following teaching strategies appeared to be under-utilized: **cooperative learning, brainstorming** and **demonstrations by learners**. The teaching strategies used most frequently according to the teacher responses were: **drilling, presentations by the teacher, demonstrations by the teacher** and **problem-solving** (*cf.* 4.3.4). During the observations, the application of teaching strategies revealed a strong tendency towards the utilization of presentations, which supports the data obtained from the questionnaire responses. Furthermore, in support of the questionnaire data, presentations by learners and cooperative learning seemed to be under-utilized.

#### **4.6.5 Section D2: Assessment strategies**

The learner responses to the questionnaire indicated that the most frequently used assessment strategies by their teachers appeared to be **tests and exams, assignments, group discussions, and research projects**. The teachers indicated that they often utilize **providing precise to the point information, presentations in class, identifying important facts in work, summarizing information, experimenting, group discussions** and **investigation** (*cf.* 4.3.5). The observations revealed that learners were given opportunities most of the time to voice their own opinions and to do presentations in class. However, no emphasis was placed on providing opportunities for the assessment of higher-order thinking, which supports the data obtained from the questionnaires.

#### **4.7 CHAPTER SUMMARY**

In this chapter, the data obtained by means of the learner and teacher questionnaires, as well as the observations, were analysed and interpreted. The following main trends emerged from the data:

It appeared as if many of the teachers who took part in the study complied with the criteria for authentic teaching. It was, however, disconcerting that there were still some teachers who apparently do not apply the principles of authentic teaching (*cf.* 4.3.1). The responses of both the teachers and the learners did not convincingly indicate that the classrooms in which the research was conducted fully adhere to the principles of authentic teaching learning and assessment (*cf.* 4.3.3).

The next chapter will deal with a summary of the study, main findings and recommendations.

## **CHAPTER FIVE**

### **FINDINGS, CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 INTRODUCTION**

In this chapter, the researcher endeavours to revisit the aims of the study in order to ascertain whether they have been achieved. Some problem questions were posed in the opening chapter of this study. They needed to be answered as the study unfolded. The researcher's task in this chapter is to check whether the literature review, the questionnaire, as well as the observations contributed to answering the problem question on which the study was based. The layout of this chapter is as follows:

- An overview of the study
- Findings from the literature review
- Findings from the empirical research
- Findings in relation to the aim and objectives of the study
- Recommendations
- Limitations of the study
- Suggestions for further research

#### **5.2 OVERVIEW OF THE STUDY**

This section intends to give a brief overview of all the previous chapters of this study. The purpose of this exercise is to focus the readers' mind on the important aspects of each chapter, so that the findings and the recommendations that will emerge from the study will link meaningfully to the literature review.

### **5.2.1 Chapter One**

The purpose of this chapter was to orientate the reader to the problem that was identified for this study. The problem statement related to poor performance in Mathematics and the merits of authentic teaching to turn the tide. The main aim of the study focussed on determining the extent to which teachers create opportunities for authentic teaching and learning in the Mathematics classroom (*cf.* 1.3)

### **5.2.2 Chapter Two**

This chapter focussed specifically on the literature dealing with authentic teaching; authentic learning and authentic assessment. In implementing authentic teaching, teachers can make mistakes and they do not have all the answers (*cf.* 2.3). Teachers have to practise what they preach (*cf.* 2.2) and place the growth and development of their learners high on their teaching agenda (*cf.* 2.3).

Learner-centered teaching should characterize authentic teaching and learning environments (*cf.* 2.3) and expect of learners to construct their own knowledge and apply knowledge to real-life contexts, (*cf.* 2.4), take control of their own learning through experimentation, inquiry and investigation (*cf.* 2.4.5). Authentic assessment within this framework is described as tasks and procedures in which learners are engaged in applying essential skills and knowledge to solve real-world problems (*cf.* 2.7). Authentic assessment involves problem-solving, critical thinking, reasoning and self-reflection (*cf.* 2.7).

### **5.2.3 Chapter Three**

This chapter elaborated on the quantitative research design used to achieve the aim and objectives of this study. In this study, the aim was to investigate the extent to which teachers apply the principles of authentic teaching and assessment in the Mathematics classroom. As the researcher decided to be an external observer whose aim was to identify characteristics of a teaching

and learning situation and to develop generalizations that contribute to theory, a quantitative research was selected. By means of questionnaires to a purposefully and conveniently selected group of Intermediate Phase Mathematics teachers and learners from the D11 District of the Gauteng Department of Education and observations of the teachers' Mathematics classrooms (*cf.* 3.6; 3.7.3) data was collected. The questionnaire data were the primary set of data collected for the research and were collected first and interpreted, after which observations were conducted and interpreted. The observations were conducted in order to support or refute the data obtained by the questionnaires and to provide a more comprehensive and detailed understanding of the application of the principles of authentic teaching, learning, and assessment in Intermediate Phase Mathematics classrooms.

#### **5.2.4 Chapter Four**

Data collected through the questionnaires and observations were analysed and interpreted in this chapter. The findings obtained from the questionnaires indicated that the teachers who took part in the research possess knowledge on what authentic teaching and learning implies, and to some extent apply the principles of authentic teaching and assessment. However, the data obtained did not conclusively indicate that the teachers implement the principles of authentic teaching and assessment on a frequent basis (*cf.* 4.3.1 - 4.3.5). The observations also indicated that the application of the principles of authentic teaching and assessment have not yet fully become reality in the classrooms of the teachers who took part in the research. Based on the results obtained, the researcher made recommendations (*cf.* 5.6) that could assist teachers with implementing the principles of authentic teaching and assessment more effectively in their Mathematics classrooms.

### **5.3 FINDINGS FROM LITERATURE REVIEW**

In order to obtain information on the principles of authentic teaching and assessment, a thorough literature review was conducted. From the literature

review the following conclusions were made regarding the effective implementation of authentic teaching and assessment.

The literature review explained authenticity as showing consistency between values and actions, which simply imply that teachers should practise what they preach (*cf.* 2.2). Authenticity refers to relating to others in such a way as to encourage their authenticity, which implies developing a relationship with learners that fosters the teachers own and their ability to be genuine and open (*cf.* 2.2). Furthermore, authenticity involves knowing and understanding how people are different from and the same as others (*cf.* 2.2). Finally, authenticity refers to being bold, taking risks and recognizing that one cannot always win over people (*cf.* 2.3) (Cranton & Carusetta, 2004b:8; Sharp, 1995:48).

According to Ray and Anderson (2000:8), Palmer (2000:6) and Renzulli *et al.* (2004:74), the authentic teacher is a teacher who acknowledges that he does not have all the answers, can make mistakes and balance deductive and prescriptive teaching with inductive and investigative teaching.

The provision of authentic learning links well with constructivist principles of teaching and learning, and implies the solving of real-life problems (*cf.* 2.4; 2.4.8), the application of knowledge in real-life contexts (*cf.* 2.4), the development of higher-order thinking skills (*cf.* 2.4.1); the construction of knowledge by learners themselves and with their peers (*cf.* 2.4.1; 2.4.5), learning that transcends to the world beyond the classroom (*cf.* 2.4.3), problem-based learning (*cf.* 2.4.6) and the provision of experiential learning through a variety of teaching strategies (*cf.* 2.4.8) (Mezirow, 2000:8; Palmer, 2000:6; Fox, 2001:24; Henry, 2002:67; Cranton & Carusetta, 2004b:7; Renzulli *et al.*, 2004:74; Hobart, 2005:12; Stewart & Brendefur, 2005:683).

Authentic assessment augurs well with the principles of assessment for learning and focuses on performance-based assessment in which problem-solving, critical thinking, comprehension, reasoning and self-reflection play an important part (*cf.* 2.7) (Custer, 2000:3; Stiggins, 2002:761; Guilkers *et al.*, 2004:67-76; Suurtamm, 2004:499).

The findings obtained from the literature review guided the construction of the questionnaires as well as the observation schedule, and were considered during the interpretation of data obtained from the questionnaires and observations.

#### **5.4 FINDINGS FROM THE EMPIRICAL RESEARCH**

The following findings were derived from the questionnaire and observation data.

Many of the teachers who took part in the study appeared to comply with the criteria for authentic teaching (*cf.* 4.3.1). The responses of both the teachers and the learners did not convincingly indicate that the classrooms in which the research was conducted fully adhere to the principles of authentic teaching; learning and assessment (*cf.* 4.3.3; 4.5). The researcher is therefore of the opinion that the teachers need support and guidance on how to effectively enhance authentic teaching and assessment in their classrooms. It appears as if certain teaching methods such as field trips, presentations, lectures, drilling and solving problems (*cf.* 4.3.4; 4.5) are favoured above others, which hampers the balanced application of teaching strategies that are required for authentic teaching (Kramer, 2006:102-106; Gradgenett & Harris, 2007:2) (*cf.* 2.4.8). The same tendency was noted for the application of assessment strategies. Tests and exams, providing precise to-the-point information, presentations in class, identifying important facts and summarizing information appeared to be the most frequently used assessment strategies (*cf.* 4.3.5). It is clear that the utilization of authentic assessment strategies that focus on problem-solving, critical thinking, comprehension, reasoning and self-reflection (Luongo-Orlando, 2003:7; Guilkers *et al.*, 2004:67-76) (*cf.* 2.7; 4.5) are under-utilized in the classrooms that took part in the research.

In the absence of clear and convincing evidence that teachers fully understand and apply the principles for authentic teaching and assessment, the researcher is concerned that learners' development of higher-order thinking skills, their ability to regulate their own learning, their self-growth, self-

confidence and self-esteem are neglected (Herman, 1992:72; Gredler, 2002:7; Luongo-Orlando, 2003:7; Guilkers *et al.*, 2004 67-76; Renzulli *et al.*, 2004:74; Stewart & Brendefur., 2005:683) (*cf.* 2.3; 2.4; 2.7), which, according to the researcher, which in turn could hamper the learners motivation and love of Mathematics.

The most problematic issues that emanated from the empirical study appeared to be the following:

- resource provision during teaching and learning (*cf.* 4.3.1; Table 4.22);
- a strong focus on the memorisation of information through the use of tests (*cf.* 4.3.5);
- lesson outcomes are not frequently discussed (*cf.* 4.3.1; 4.3.3);
- learner involvement in self-reflective activities is limited (*cf.* 4.3.3; Table 4.24);
- limited real-life experiences (*cf.* Table 4.16; Table 4.23);
- learners not frequently involved in presentations and demonstrations (*cf.* Table 4.18; Table 4.25); and
- limited opportunities provided for learners to work with their peers (*cf.* 4.3.3; Table 4.25)

The researcher argues that based on the results of the empirical study, teachers appear to be still too prescriptive during their teaching in stead of promoting a more investigative climate in their classrooms (Renzulli *et al.*, 2004:74) (*cf.* 2.4).

## **5.5 FINDINGS IN RELATION TO THE AIM AND OBJECTIVES OF THE STUDY.**

This study aimed at unearthing facts regarding the extent to which the principles of authentic teaching and assessment are applied in Mathematics classrooms and aimed to achieve the under-mentioned objectives (*cf.* 1.3).

### **Objective 1: To determine what authentic teaching and assessment entail**

Through the literature review, the researcher understood that in authentic teaching, teachers and learners grow together (*cf.* 2.3). According to Ray and Anderson (2000:8) and Palmer (2006:6), the authentic teacher is a teacher who acknowledges that he does not have all the answers, can make mistakes and balance deductive and prescriptive teaching with inductive and investigative teaching. The provision of authentic learning links well with constructivist principles of teaching and learning, and implies the solving of real-life problems (*cf.* 2.4; 2.4.8), the application of knowledge in real-life contexts (*cf.* 2.4), the development of higher-order thinking skills (*cf.* 2.4.1); the construction of knowledge by learners themselves and with their peers (*cf.* 2.4.1; 2.4.5), learning that transcends to the world beyond the classroom (*cf.* 2.4.3), problem-based learning (*cf.* 2.4.6) and the provision of experiential learning through a variety of teaching strategies (*cf.* 2.4.8) (Mezirow, 2000:8; Palmer, 2000:6; Fox, 2001:24; Henry, 2002:67; Cranton & Carusetta, 2004b:7; Renzulli *et al.*, 2004:74; Hobart, 2005:12; Stewart & Brendefur, 2005:683).

Authentic assessment augurs well with the principles of assessment for learning and focuses on performance-based assessment in which problem-solving, critical thinking, comprehension, reasoning and self-reflection play an important part (*cf.* 2.7) (Custer, 2000:3; Stiggins, 2002a:761; Guilkers *et al.*, 2004:67-76; Suurtamm, 2004:499).

**Objective 2: To establish teachers' knowledge regarding authentic teaching and learning in the Mathematics classroom**

This objective was achieved by means of the data obtained by the questionnaire responses of the teachers for section B of the questionnaire. It appears as if many of the teachers who took part in the study have knowledge about the principles of authentic teaching and learning (*cf.* 4.3.1; 4.3.2).

**Objective 3: To establish learners' perceptions regarding authentic teaching and learning in the Mathematics classroom**

The majority of the learner responses indicated that they are in favour of the principles being incorporated in their Mathematics classrooms (*cf.* 4.3.1).

**Objective 4: To investigate how teachers enhance authentic teaching and learning in the Mathematics classroom**

This objective was achieved through the empirical research by means of questionnaires and observations. It appeared as if many of the teachers who took part in the study complied with the criteria for authentic teaching. It was, however, disconcerting that there were still some teachers who apparently do not apply the principles of authentic teaching (*cf.* 4.3.1). Furthermore, it appeared that the majority of learners strongly agreed and agreed to the importance of the principles of authentic learning and assessment, and that the teachers who, in turn, also strongly agreed and agreed to all of the statements, except statement 11, apparently apply these principles during teaching (*cf.* 4.3.2). The responses of both the teachers and the learners did not convincingly indicate that the classrooms in which the research was conducted fully adhere to the principles of authentic teaching and assessment (*cf.* 4.3.3).

The observations revealed that teachers frequently made learners aware of the outcomes of instruction, but did not provide many opportunities for learners to work with their peers, to voice their opinions, to demonstrate what they have learned, to involve learners in negotiating meaning and decision-

making (*cf.* 4.5). Furthermore, learners' evaluation of their own work and the work of their peers, were underemphasized. According to the learner responses, the following teaching strategies appeared to be under-utilized: **cooperative learning, brainstorming and demonstrations by learners.** The teaching strategies used most frequently according to the teacher responses were: **drilling, presentations by the teacher, demonstrations by the teacher and problem-solving** (*cf.* 4.3.4). During the observations, the application of teaching strategies revealed a strong tendency towards the utilization of presentations, which supports the data obtained from the questionnaire responses. Furthermore, in support of the questionnaire data, presentations by learners and cooperative learning appeared to be under-utilized (*cf.*4.5).

The most frequently used assessment strategies by the teachers appeared to be **tests and exams, assignments, group discussions, and research projects.** The teachers indicated that they often utilize **providing precise to the point information, presentations in class, identifying important facts in work, summarizing information, experimenting, group discussions and investigation** (*cf.* 4.3.5; Table 4.26). In support of the questionnaire data, the observations revealed that no emphasis was placed on assessment of higher-order thinking.

**Objective 5: To determine if there is a difference between the learner and teacher responses regarding the extent to which opportunities for authentic teaching and assessment are created in Mathematics classrooms**

No statistical significant differences were noted between the responses of the teachers and learners regarding the application of the principles of authentic teaching and learning (*cf.* 4.3.3). The researcher therefore accepts the null hypotheses which indicated that there will be not statistical significant difference between the learner and teacher responses regarding the application of the principles of authentic teaching and learning in the Mathematics classroom. The acceptance of the null hypothesis is based on

the fact that the differences between the mean scores for the learner and teacher responses for sections C, D and E of the questionnaire indicated that  $p > 0.05 = 0.206, 0.435$  and  $0.805$  for the respective questionnaire sections. The alternative hypothesis is therefore accepted, as no statistical significant differences were noted.

**Objective 6: To make suggestions to improve the authenticity of teaching, learning and assessment in Mathematics**

According to findings obtained from the questionnaires and the observations the researcher concluded that teachers do need additional guidance and support in order to apply all the principles of authentic teaching and assessment effectively. Recommendations in this regard are made in the following section.

## **5.6 RECOMMENDATIONS**

In light of the findings, the researcher recommends the following:

- It is imperative for teachers to make an effort to familiarize themselves with the principles of authentic teaching and assessment in order to improve their knowledge and understanding. This will enable them to become acquainted with some of the principles of authentic teaching and learning which appeared to be under-utilized during the study, namely the role of social support during learning, and the importance of providing opportunities for the development of higher-order thinking, the provision of resources, providing learning experiences that relate to real life, planning opportunities for self-reflection and learner involvement in presentations and discussions (*cf.* 4.3.1- 4.3.5).
- In order to develop learners' knowledge and skills that will enable them to implement higher-order thinking, in-service teachers should register at Higher Education Institutions for courses in order to become acquainted with the variety of teaching and assessment strategies that could be utilized to enhance authentic teaching and learning in Mathematics.

- The Department of Education should introduce extensive and comprehensive training and workshop programmes that will provide the type of training which will help teachers to develop and enhance their knowledge and understanding of how to translate the principles of authentic teaching, learning and assessment into practice.
- In addition to the above-mentioned workshops, experts in the field of using multiple resources during teaching, and how to vary teaching and assessment strategies should be invited by the Department of Education to visit schools to give extensive training and guidelines to teachers in the classroom.
- Teachers themselves should engage in discussions with their colleagues in order to share their knowledge and understanding regarding the effective use of resources, and the application of a variety assessment and teaching strategies. They could visit one another's classrooms and evaluate their implementation practices in order to check and verify the extent to which they are able to engage learners in Mathematics lessons effectively. Teachers should, from time to time, engage in self-assessment activities or reflection to check and verify their level of competency regarding the implementation of authentic teaching and assessment principles (Cranton & Carusetta, 2004b:7) (*cf.* 2.2).
- Teachers should be encouraged and supported to belong to the Associations of Mathematics Teachers that present seminars and conferences where topics related to Mathematics teaching, learning and assessment are discussed.
- This research also points to important implications for teacher training. Teacher training programmes should equip prospective teachers with the necessary knowledge and skills to be experts or specialists, not only in terms of Mathematics content, but also to equip teachers with expert knowledge in terms of the methodology for authentic teaching and assessment.

## 5.7 LIMITATIONS OF THE RESEARCH

Bearing the number of limitations in mind that the researcher identified for this research, the researcher acknowledges that only tentative conclusions regarding the extent, to which the principles of authentic teaching and assessment are applied in the Mathematics classroom, can be formulated. The researcher identified the following limitations:

- Only a quantitative research approach was utilized, which limited the amount of data the researcher had available. By integrating some qualitative methods for data collection, such as interviews, a more complete and holistic understanding of the application of the principles of authentic teaching and assessment, could have been obtained.
- The current sample was only bounded to one education district which included a small number of teachers. The generalizability of the results is thus not possible. Similar research with especially larger samples of teachers and learners in other education districts from other cultural groups and other Grades is necessary to report conclusively on the extent to which teachers apply the principles of authentic teaching and assessment in Mathematics classrooms.
- The researcher used convenient sampling due to time and logistical constraints, and acknowledges that bias might have been built into the sample.
- The observation schedule was too comprehensive, and the researcher and the co-observer found the observations challenging. A reduction in the number of items could assist in obtaining more reliable information.
- As it was not indicated as part of the objectives of the study, the researcher did not examine the influence of the various biographical variables on the perceptions of the learners and teachers regarding the extent to which the principles of authentic teaching and assessment are applied. Such an examination could have provided more detailed

information regarding the application of the principles of authentic teaching and assessment. The researcher did not establish whether the teachers were really trained to teach Mathematics. This could have provided deeper insight into the provision of authentic teaching and learning experiences.

- The questionnaires were not translated to accommodate the respondents whose home language was Sesotho and Afrikaans. This might have posed problems in terms of clarity and meaning of the questionnaire items.

## **5.8 SUGGESTIONS FOR FURTHER RESEARCH**

This study made the researcher aware of related topics that require further research. The following suggestions are made for further research:

- A study to determine how factors such as time, overcrowded classes and lack of resources impact on the effective application of the principles of authentic teaching and learning in the Mathematics classroom.
- A study to determine the extent to which authentic teaching and learning in Mathematics impact on learner achievement.
- Further research can be done in other provinces in order to understand different perceptions of teachers and learners regarding the creation of opportunities for authentic teaching and learning in Mathematics classrooms.
- This research should be extended to larger groups of teachers and learners, and qualitative methods of data collection such as interviews should be utilized to gauge teachers' understanding of authentic teaching and assessment and how their understanding translates into classroom-practice.
- An investigation into the extent to which real-life problems and transcendence to the world beyond the classroom are dealt with in the context of authentic teaching and assessment in Mathematics classrooms

would provide interesting information on two important aspects that are central to authenticity.

## **5.9 CONCLUSION**

Although the application of the principles of authentic teaching and learning is difficult and challenging, and the present study indicates that the current implementation practices of the teachers who took part in the study are not fully in line with the principles of authentic teaching, learning and assessment; the implementation thereof is necessary and compulsory as prescribed by the National Curriculum Statement. Authentic teaching and learning supports the holistic development of learners within the school context. It is therefore important that teachers accept the challenge to find ways of familiarizing themselves with the principles underpinning authentic teaching, learning and assessment.

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## **APPENDIX A**

### **PERMISSION FROM GDE TO CONDUCT RESEARCH**



UMnyango WezeMfundo  
Department of Education

Lefapha la Thuto  
Departement van Onderwys

Date:	11 March 2008
Name of Researcher:	Mrwebi Mandosi Betty-Sarah
Address of Researcher:	No. 25 Zone 10
	Extension 2
	Sebokeng 1983
Telephone Number:	0165943594/0829721558
Fax Number:	0118553152
Research Topic:	An investigation into the provision of authentic teaching and learning experiences in the mathematics classroom
Number and type of schools:	8 Primary Schools
District/s/HO	Johannesburg South

### **Re: Approval in Respect of Request to Conduct Research**

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

Permission has been granted to proceed with the above study subject to the conditions listed below being met, and may be withdrawn should any of these conditions be flouted:

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*

4. A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.
5. The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.
6. Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.
7. Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year.
8. Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.
9. It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.
10. The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the Institutions and/or the offices visited for supplying such resources.
11. The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.
12. On completion of the study the researcher must supply the Director: Knowledge Management & Research with one Hard Cover bound and one Ring bound copy of the final, approved research report. The researcher would also provide the said manager with an electronic copy of the research abstract/summary and/or annotation.
13. The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.
14. Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

  
Tom Waspe  
CHIEF INFORMATION OFFICER

The contents of this letter has been read and understood by the researcher.

Signature of Researcher:



Date:

21-03-2008

## **APPENDIX B**

### **CONSENT FORMS (RESEARCH PARTICIPANTS)**

## Dear learner

I am busy with a research study for my Masters degree (MEd). I need your assistance to provide me with information to complete the study. This document will provide you with information regarding the project and what your involvement will entail. If you feel comfortable with the contents of the explanation I will appreciate it if you could sign the section indicating your consent to take part in the study. Participation is voluntary and can be terminated at any time you wish.

My research wants to determine the characteristics of teaching in the Mathematics classroom in the Intermediate Phase. I would like you to complete a questionnaire to indicate how you presently perceive the teaching and learning in the Mathematics classroom. This will take approximately 20 minutes and will be done after school or during break. All the information collected will be kept confidential and will not be discussed with anybody else other than my supervisor. No names will be attached; each participant will be identified by a code.

The research is conducted by a Master student, M.B Mrwebi, under the supervision of Prof. M.M Grosser from the school of Educational Sciences, North-West University (Vaal Triangle Campus). If you have any questions or queries you can contact Prof. Grosser at (016) 910 – 3063 (work).

Consent:

I \_\_\_\_\_ (full name) have read and understand the nature of my participation in the project and agree to participate.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

## Dear teacher

I am busy with a research study for my Masters degree (MEd). I need your assistance to provide me with information to complete the study. This document will provide you with information regarding the project and what your involvement will entail. If you feel comfortable with the contents of the explanation I will appreciate it if you could sign the section indicating your consent to take part in the study. Participation is voluntary and can be terminated at any time you wish.

My research wants to determine if teaching in the Mathematics classroom in the Intermediate Phase is authentic. I would like you to complete a questionnaire in which you need to evaluate your own teaching and learning practice. This will take approximately 20 minutes and can be done at a time suitable to you. Furthermore, I would also like to conduct 3 unannounced observations of your teaching in the Mathematics classroom, in order to determine the incidences of authentic teaching. This will be arranged with you in advance and at times suitable to you. All the information collected will be kept confidential and will not be discussed with anybody else other than my supervisor. No names will be attached; each participant will be identified by a code.

The research is conducted by a Master student, M.B Mrwebi, under the supervision of Prof. M.M Grosser from the school of Educational Sciences, North-West University (Vaal Triangle Campus). If you have any questions or queries you can contact Prof. Grosser at (016) 910 – 3063 (work).

Consent:

I \_\_\_\_\_ (full name) have read and understand the nature of my participation in the project and agree to participate.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

**Dear Parent**

I am busy with a research study for my Masters degree (MEd). I need your assistance to provide me with information to complete the study. This document will provide you with information regarding the project and what your involvement will entail. If you feel comfortable with the contents of the explanation I will appreciate it if you could sign the section indicating your consent to take part in the study. Participation is voluntary and can be terminated at any time you wish so.

My research wants to determine if teaching in the Mathematics classroom in the Intermediate Phase is authentic. I would like to involve ..... (name of learner) in the research.

My intention is to obtain the perspectives of learners regarding the teaching practice of their teachers. For this purpose a questionnaire will be completed by the learners. The completion of the questionnaire will take approximately 20 minutes and will be done after school hours or during break. All the information collected will be kept confidential and will not be discussed with anybody else other than my supervisor. No names will be attached; each participant will be identified by a code.

The research is conducted by a Master student, M.B Mrwebi, under the supervision of Dr. M.M Grosser from the school of Educational Sciences, North-West University (Vaal Triangle Campus). If you have any questions or queries you can contact Dr. Grosser at (016) 910 – 3063 (work).

**Consent:**

I \_\_\_\_\_ (full name) have read and understand the nature of participation in the project and agree that .....(name of learner) may participate.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

## Dear Principal

I am busy with a research study for my Masters degree (Med). I need your assistance to provide me with information to complete the study. This document will provide you with information regarding the project and what your involvement will entail. If you feel comfortable with the contents of the explanation I will appreciate it if you could sign the section indicating your consent to take part in the study. Participation is voluntary and can be terminated at any time you wish so.

My research wants to determine if teaching in the Mathematics classroom in the Intermediate Phase is authentic teaching. I would like to involve Grade 4, 5 and 6 learners and teachers at your school for this purpose. Learners and teachers will be required to complete questionnaires that will take about 20 minutes to determine the characteristics of the teaching and learning in the Mathematics classrooms. This will be done after school or during break. Furthermore, I would like to conduct 3 observations in the Mathematics classrooms in order to determine the incidences of authentic teaching. The observations will be arranged with the teachers at times convenient for them. All the information collected will be kept confidential and will not be discussed with anybody else other than my supervisor. No names of schools or participants will be linked to the interpretation of data. Each participant will be identified by a code.

The research is conducted by a Master student, M.B Mrwebi, under the supervision of Prof. M.M Grosser from the school of Educational Sciences, North-West University (Vaal Triangle Campus). If you have any questions or queries you can contact Prof. Grosser at (016) 910 – 3063 (work).

Consent:

I \_\_\_\_\_ (full name) have read and understand the nature of participation in the project and agree to participate.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

## **APPENDIX C**

### **ETHICAL CLEARANCE**



Private Bag X6001, Potchefstroom  
South Africa 2520

Tel: (018) 299-4900  
Faks: (018) 299-4910  
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Prof Mary Grosser

**Ethics Committee**  
Tel +27 18 299 4850  
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Email [Ethics@nwu.ac.za](mailto:Ethics@nwu.ac.za)

22 September 2009

### ETHICS APPROVAL OF PROJECT

The North-West University Ethics Committee (NWU-EC) hereby approves your project as indicated below. This implies that the NWU-EC grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the project may be initiated, using the ethics number below.

<b>Project title:</b> An investigation into the provision of authentic teaching and learning experiences in the Mathematics classroom	
<b>Student working on project:</b> B Mandosi	
<b>Ethics number:</b>	N W U - 0 0 0 4 8 - 0 9 - A 2
<b>Approval date:</b> 22 September 2009	<b>Expiry date:</b> 21 September 2014

Special conditions of the approval (if any): None

**General conditions:**

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The project leader (principle investigator) must report in the prescribed format to the NWU-EC:
  - annually (or as otherwise requested) on the progress of the project,
  - without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-EC. Would there be deviated from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-EC and new approval received before or on the expiry date.
- In the interest of ethical responsibility the NWU-EC retains the right to:
  - request access to any information or data at any time during the course or after completion of the project;
  - withdraw or postpone approval if:
    - any unethical principles or practices of the project are revealed or suspected,
    - it becomes apparent that any relevant information was withheld from the NWU-EC or that information has been false or misrepresented,
    - the required annual report and reporting of adverse events was not done timely and accurately,
    - new institutional rules, national legislation or international conventions deem it necessary.

The Ethics Committee would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the Ethics Committee for any further enquiries or requests for assistance.

Yours sincerely

Prof MMJ Lowes  
(chair NWU Ethics Committee)

Prof M. Monteith  
(Chairman: NWU Ethics Committee: Teaching and Learning)

## **APPENDIX D**

### **TEACHER QUESTIONNAIRE**

## TEACHER QUESTIONNAIRE

**Dear teacher**

***I am currently busy with a Masters Degree at the North-West University, Vaal Triangle Campus. My research wants to determine if teaching in the Mathematics classroom relates to real life experiences. I will appreciate it if you can complete the questionnaire. You will complete the questionnaire anonymously and all information will be handled with the utmost confidentiality. Thank you, your time and cooperation are valued.***

**Mrs B Mrwebi**

### SECTION A: BIOGRAPHICAL DATA

**Please indicate your response by marking with an X in the appropriate block**

1.	Your gender	1. Female	2. Male			
2.	Your age	1. Younger than 21 years	2. 21 – 30 years	3. 31 – 40 years	4. 41 – 50 years	5. Older than 50 years
3.	What level of education have you achieved?	1. Below Matric	2. Matric	3. Matric and certificate	4. Matric and diploma	5. Matric and degree(s)
4.	Position	1. Principal	2. Deputy		3. HOD	4. Educator
5.	Type of school in which you teach	1. Ex model C school			2. Township school	3. Farm school
6.	Who owns your school?	1. Public			2. Private	
7.	Number of years in teaching profession	1. 0-5	2. 6-10	3. 11-15	4. 16+	
8.	Experience in teaching	1.	2.	3.	4.	

	Mathematics	0-5	6-10	11-15	16+
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**SECTION B: GENERAL PRINCIPLES REGARDING THE PROVISION OF AUTHENTIC TEACHING, LEARNING AND ASSESSMENT EXPERIENCES IN THE MATHEMATICS CLASSROOM**

**B1: Authentic teaching**

Indicate the extent to which you agree or disagree with the following statements being characteristics of Mathematics teachers by marking with an X in the appropriate block.

	<b>Mathematics teachers.....</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
1.	can make mistakes	1	2	3	4
2.	should have all the answers	1	2	3	4
3.	should have open relationships with learners (learners should not be afraid to talk to their teachers)	1	2	3	4
4.	should constantly ask themselves if the way they teach is suitable.	1	2	3	4
5.	should see each learner as an individual in his own right.	1	2	3	4
6.	should ask themselves if they can improve on the way they teach.	1	2	3	4
7.	should practice what they preach	1	2	3	4
8.	should help learners to develop their potential	1	2	3	4
9.	should learn together with their learners	1	2	3	4
10.	should try out new methods of teaching	1	2	3	4

	<b>Mathematics teachers.....</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
11.	should tell learners what they expect of them	1	2	3	4
12.	should know what will help learners to learn better.	1	2	3	4
13.	should be a coach.	1	2	3	4
14.	should be an instructor.	1	2	3	4
15.	should provide learners with resources during teaching.	1	2	3	4
16.	should present learners with problems to solve during teaching.	1	2	3	4
17.	should involve all the senses of learners during teaching.	1	2	3	4

## **B2: Authentic learning and assessment**

Indicate the extent to which you agree or disagree with the following being principles of authentic teaching, learning and assessment in a Mathematics classroom by marking with an X in the appropriate block.

	<b>Teaching, learning and assessment should.....</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
1.	be related to real-life situations	1	2	3	4
2.	involve exploration	1	2	3	4
3.	involve inquiry				
4.	involve learners in solving real life problems	1	2	3	4

	Teaching, learning and assessment should.....	Strongly agree	Agree	Disagree	Strongly disagree
5.	involve learners in giving their own opinions during teaching	1	2	3	4
6.	let learners judge information	1	2	3	4
7.	let learners summarise information	1	2	3	4
8.	let learners be involved in conversations with teachers and peers	1	2	3	4
9.	let learners separate important information from unimportant information				
10.	allow learners to have a say in what they should learn	1	2	3	4
11.	allow learners to have a say in how things should be learned				
12.	let learners move around in class when learning	1	2	3	4
13.	let learners demonstrate what they have learned	1	2	3	4
14.	allow learners to take responsibility for their own learning	1	2	3	4
15.	let learners be creators of knowledge	1	2	3	4
16.	challenge learners	1	2	3	4
17.	provide clear assessment criteria to learners.	1	2	3	4
18.	not only expect learners to memorize information.	1	2	3	4
19.	assess learners' own views on a topic.	1	2	3	4
20.	not only make use of tests to assess learners	1	2	3	4

**SECTION C: THE PRACTICAL APPLICATION OF AUTHENTIC TEACHING, LEARNING AND ASSESSMENT (What happens in the classroom?)**

Indicate how frequently the following takes place during the teaching, learning and assessment in your Mathematics classroom by marking with an X in the appropriate block.

<b>Key: 1 =Almost always    2 =Often    3 = Sometimes    4 = Very seldom</b>					
1.	I discuss the outcomes for each lesson with the learners	1	2	3	4
2.	I ask learners to demonstrate what they have learned	1	2	3	4
3.	I ask learners to plan our work	1	2	3	4
4.	I ask learners to check their own work before they submit it	1	2	3	4
5.	I ask learners to evaluate their own work	1	2	3	4
6.	I allow learners to work with their classmates	1	2	3	4
7.	I use a variety of strategies to assess learners	1	2	3	4
8.	I use portfolios as an assessment tool	1	2	3	4
9.	I use testing as an assessment strategy	1	2	3	4
10.	I provide learners with constant feedback	1	2	3	4
11.	I provide learners with more than one chance to do their work	1	2	3	4
12.	I ask for learners' opinions during teaching	1	2	3	4
13.	I inform the learners' parents when I experience problems	1	2	3	4
14.	I involve learners in the decision-making process	1	2	3	4
15.	I am open to new ideas	1	2	3	4

## SECTION D: TEACHING AND ASSESSMENT STRATEGIES

Indicate how often you utilize following teaching and assessment strategies when you teach Mathematics by marking with an X in the appropriate block.

<b>D1: Teaching strategies</b>	<b>Almost always</b>	<b>Often</b>	<b>Some- times</b>	<b>Very seldom</b>
1. Lectures	1	2	3	4
2. Drilling	1	2	3	4
3 .Worksheets to complete	1	2	3	4
4. Presentations by the teacher	1	2	3	4
5. Demonstrations by the teacher	1	2	3	4
6 .Presentations by the learner	1	2	3	4
7. Demonstrations by the learner	1	2	3	4
8. Solving problems	1	2	3	4
9. Making posters	1	2	3	4
10. Role plays	1	2	3	4
11. Projects	1	2	3	4
12. Field trips/Excursions	1	2	3	4
13. Debates	1	2	3	4
14. Crossword puzzles	1	2	3	4
15. Cooperative learning (working in groups with class mates)	1	2	3	4
16. Brainstorming ideas	1	2	3	4

<b>D2: Assessment tasks and strategies</b>	<b>Almost always</b>	<b>Often</b>	<b>Some- times</b>	<b>Very seldom</b>
17. To summarize information	1	2	3	4
18. To give our own opinions	1	2	3	4
19. To compare things	1	2	3	4
20. To judge something	1	2	3	4
21. To indicate the important facts in a piece of work	1	2	3	4
22. To indicate the unimportant facts in a piece of work.	1	2	3	4
23. Providing precise to the point information	1	2	3	4
24 .Discovering and exploring	1	2	3	4
25 .Experimenting	1	2	3	4
26. Group discussions	1	2	3	4
27. Research projects	1	2	3	4
28. Investigations	1	2	3	4
29. Assignments	1	2	3	4
30. Tests/Exams	1	2	3	4
31. Presentations in class	1	2	3	4
32. Translation tasks: graphs, diagrams, mind maps	1	2	3	4

Thank you for your cooperation!

## **APPENDIX E**

### **LEARNER QUESTIONNAIRE**

## LEARNER QUESTIONNAIRE

*Dear learner*

*I am currently busy with a Masters Degree at the North-West University, Vaal Triangle Campus. My research wants to determine if teaching in the Mathematics classroom relates to real life experiences. I will appreciate it if you can complete the questionnaire. You will complete the questionnaire anonymously and all information will be handled with the utmost confidentiality. Thank you, your time and cooperation are valued.*

*Mrs B Mrwebi*

### SECTION A: BIOGRAPHICAL DATA

**Please indicate your response by marking with an X in the appropriate block**

1.	Your gender	1. Female		2. Male		
2.	Your age	1. 9-10	2. 11-12	3. 13-15	4. 16 and above	
3.	Which Grade are you in?	1. Grade 4		2. Grade 5	3. Grade 6	
4.	Where is your school located?	1. In Town	2. Suburban area	3. In a Township	4. On a farm	5. Squatter area
5.	The type of school you attend?	1. Public			2. Private	

**SECTION B: GENERAL PRINCIPLES REGARDING THE PROVISION OF AUTHENTIC TEACHING, LEARNING AND ASSESSMENT EXPERIENCES IN THE MATHEMATICS CLASSROOM**

**B1: Authentic teaching**

Indicate the extent to which you agree or disagree with the following being part of teaching and learning in the Mathematics classroom by marking with an X in the appropriate block.

	<b>A Mathematics teacher.....</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
1.	can make mistakes	1	2	3	4
2.	should have all the answers	1	2	3	4
3	should have open relationships with learners (learners should not be afraid to talk to their teachers)	1	2	3	4
4.	should constantly ask if the way he/she teaches is suitable	1	2	3	4
5.	should see each learner as an individual in his own right.	1	2	3	4
6	should ask him/herself if he/she can improve on the way he/she teaches	1	2	3	4
7.	should practise what he/she preaches	1	2	3	4
8.	should help learners to develop their potential	1	2	3	4
9.	should learn together with the learners	1	2	3	4
10.	should try out new methods of teaching	1	2	3	4
11.	should tell learners what they expect of them	1	2	3	4
12.	should know what will help learners to learn better	1	2	3	4

	<b>A Mathematics teacher.....</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
13.	should be a coach	1	2	3	4
14.	should be an instructor	1	2	3	4
15.	should provide learners with resources during teaching	1	2	3	4
16.	should present learners with problems to solve during teaching	1	2	3	4
17.	should involve all the senses of the learners during teaching.	1	2	3	4

**B2: Authentic teaching, learning and assessment**

Indicate the extent to which you agree or disagree with the following statements about the following being part of teaching, learning and assessment in the Mathematics classroom by marking with an X in the appropriate block.

	<b>Teaching, learning and assessment should.....</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
1.	be related to real-life situations	1	2	3	4
2.	involve exploration	1	2	3	4
3.	involve inquiry				
4.	involve learners in solving real-life problems	1	2	3	4
5.	involve learners in giving their own opinions during teaching	1	2	3	4
6.	let learners judge information	1	2	3	4

	<b>Teaching, learning and assessment should.....</b>	<b>Strongly agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly disagree</b>
7.	let learners summarize information	1	2	3	4
8.	let learners be involved in conversations with teachers and peers	1	2	3	4
9.	let learners separate important information from unimportant information				
10.	allow learners have a say in what they should learn	1	2	3	4
11.	allow learners have a say in how things should be learned				
12.	let learners move around in class when learning	1	2	3	4
13.	let learners demonstrate what they have learned	1	2	3	4
14.	allow learners to take responsibility for their own learning	1	2	3	4
15.	let learners be creators of knowledge	1	2	3	4
16.	challenge learners	1	2	3	4
17.	provide clear assessment criteria to learners.	1	2	3	4
18.	not only expect learners to memorize information.	1	2	3	4
19.	assess learners' own views on a topic.	1	2	3	4
20.	not only make use of tests to assess learners	1	2	3	4

**SECTION C: THE PRACTICAL APPLICATION OF AUTHENTIC TEACHING, LEARNING AND ASSESSMENT (What happens in the classroom?)**

Indicate how frequently the following takes place during teaching, learning and assessment in your Mathematics classroom by marking with an X in the appropriate block.

<b>Key: 1 =Almost always    2 =Often    3 = Sometimes    4 = Very seldom</b>					
1.	The teacher discusses the outcomes for each lesson with the learners	1	2	3	4
2.	The teacher asks us to demonstrate what we have learned	1	2	3	4
3.	The teachers asks us to plan our work	1	2	3	4
4.	The teacher asks us to check our own work before we submit it	1	2	3	4
5.	The teachers asks us to evaluate our own work	1	2	3	4
6.	The teachers allows us to work with our classmates	1	2	3	4
7.	The teacher uses a variety of strategies to assess us	1	2	3	4
8.	Portfolios are used in class	1	2	3	4
9.	Testing is used as an assessment strategy	1	2	3	4
10.	Learners are provided with constant feedback	1	2	3	4
11.	The teacher provides us with more that one chance to do our work	1	2	3	4
12.	The teacher asks for our opinions during teaching	1	2	3	4
13.	My parents are informed when I experience problems	1	2	3	4
14.	Learners are involved in the decision-making process	1	2	3	4
15.	The teacher is open to new ideas	1	2	3	4

## SECTION D: TEACHING AND ASSESSMENT STRATEGIES

Indicate how often the following teaching and assessment strategies are utilized in your Mathematics classroom by marking with an X in the appropriate block.

<b>D1: Teaching strategies</b>	<b>Almost always</b>	<b>Often</b>	<b>Some- times</b>	<b>Very seldom</b>
1. Lectures	1	2	3	4
2. Drilling	1	2	3	4
3. Worksheets to complete	1	2	3	4
4. Presentations by the teacher	1	2	3	4
5. Demonstrations by the teacher	1	2	3	4
6 .Presentations by the learner	1	2	3	4
7. Demonstrations by the learner	1	2	3	4
8. Solving problems	1	2	3	4
9. Making posters	1	2	3	4
10. Role plays	1	2	3	4
11.Projects	1	2	3	4
12. Field trips/Excursions	1	2	3	4
13. Debates	1	2	3	4
14. Crossword puzzles	1	2	3	4
15. Cooperative learning (working in groups with class	1	2	3	4

mates)				
16. Brainstorming ideas	1	2	3	4
<b>D2: Assessment tasks and strategies</b>	<b>Almost always</b>	<b>Often</b>	<b>Some- times</b>	<b>Very seldom</b>
17. To summarize information	1	2	3	4
18 .To give our own opinions	1	2	3	4
19. To compare things	1	2	3	4
20. To judge information	1	2	3	4
21. To indicate the important facts in a piece of work	1	2	3	4
22. To indicate the unimportant facts in a piece of work.	1	2	3	4
23. Providing precise to the point information	1	2	3	4
24. Discovering and exploring	1	2	3	4
25. Experimenting	1	2	3	4
26. Group discussions	1	2	3	4
27. Research projects	1	2	3	4
28. Investigations	1	2	3	4
29. Assignments	1	2	3	4
30. Tests/Exams	1	2	3	4
31. Presentations in class	1	2	3	4
32. Translation tasks: graphs, diagrams, mind maps	1	2	3	4

Thank you for your cooperation!

## **APPENDIX F**

### **OBSERVATION SCHEDULE**

**A. Information on the provision of authentic teaching and learning experiences in the Mathematics classroom.**

**1. Authentic Teaching**

Incidences to be observed	Frequency											
	12 intervals of 5 minutes each											
Authentic Teaching	1	2	3	4	5	6	7	8	9	10	11	12
1. Teacher has open relationship with learners (learners participated actively & freely in activities)												
2. Teaching focuses on giving knowledge.												
3. Teaching focuses on giving skills.												
4. Teacher assesses pre-knowledge of learners.												
5. Teacher uses more than one method during teaching.												
6. Teacher coaches learners during teaching.												
7. Teacher is a facilitator												
8. Teacher provides learners with resources during teaching.												

**2. Authentic learning and assessment**

Incidences to be observed	Frequency											
	12 intervals of 5 minutes each											
Authentic learning	1	2	3	4	5	6	7	8	9	10	11	12
1. Learners solve problems												

2. Learning tasks relate to real-life situations.												
3. Learners are involved in discussions with teacher and peers												
4. Assessment criteria are clear to learners												
5. Teacher not only uses tests to assess learners.												

**B. Practical application of authentic teaching, learning and assessment**

Incidences to be observed	Frequency											
	12 intervals of 5 minutes each											
	1	2	3	4	5	6	7	8	9	10	11	12
1. The teacher discusses or makes learners aware of the outcomes of the lesson												
2. Teacher allows learners to work with their peers / classmates												
3. Teacher allows for learners' opinions during teaching												
4. Learners are involved in decision making during lessons												
5. Learners demonstrate what they have learned.												
6. Learners are allowed to evaluate their own work / work of their peers.												
7. Meaning is negotiated between teacher & learners.												
8. Teaching moves from easy to difficult												

### C. Teaching Strategies

Incidences to be observed	Frequency											
	12 intervals of 5 minutes each											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Presentation and demonstration by the teacher												
2. Presentation and demonstration by the learner												
3. Co-operative learning (working in groups with classmates)												
4. Brainstorming ideas												
5. Worksheets to complete												
6. Other												

### D. Assessment Tasks and strategies

Incidences to be observed	Frequency											
	12 intervals of 5 minutes each											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Learners summarize information												
2. Comparing things												
3. Learners giving their own opinion												
4. Presenting in class												
5. Translation tasks: graphs, diagrams, mind maps												
6. Higher-order thinking is assessed e.g evaluate,												

analyse												
7. Other e.g. Homework activity given to learners												