

**THE RELATIONSHIP BETWEEN LEARNER
VOLITIONAL STRATEGIES, LEARNING CONTEXT
AND THE LEARNING OF MATHEMATICS
IN GRADE 10**

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ABSTRACT

It is known that the status with regard to teaching and learning of mathematics in South Africa is below norm. One of the reasons for this situation is the fact that many mathematics educators experience problems in assisting learners to invest effort voluntarily in task performance, as well as in strategic plans to maintain their learning intentions. Since learners' reasons for lack of maintenance of intentions and keeping onto learning agenda can not be addressed well if they are not understood, more research studies directed towards investigating these problems need to be done. It is for this reason that this study was aimed at investigating use of volitional strategies, study orientation in mathematics and learning context in relation to performance.

The study was done on selected schools with consistent good performance in mathematics (matric pass rate > 80%) for past three to five years. Also included were schools with consistent low performance (matric pass rate < 30%) in the same period. Mathematics teachers of the affected schools were included. The results of the empirical survey reveal the presence of strong significant link between learner perceptions with regard to use of volitional strategies and study orientation. The positive study orientation and volitional strategy use increased learner attributive effect on performance. Furthermore in particular this study reveals strong negative correlation of emotional perseverance inhibition and emotional perseverance rumination and strong positive correlation between failure control and performance.

In addition, this study unveiled significant difference between study milieu and learning context. There was moderate impact difference noticed in attitudes, anxiety, study-habits and information processing between schools. Deduction that a suitable learning context moderately to strongly affects aspects of study orientation was made. Learners at schools with high tests scores most favourably perceived the use of attentional distractability, emotion control, emotional perseverance rumination, and stress reducing than at other schools. Therefore the deduction is made that learning context induced volitional

strategy use, which impacted on learner achievement. These findings are similar to those made by other researchers on these topics worldwide.

An important contribution made by this study is that it, in a South African context, sheds light both on the need for use of volitional strategies and also presents contextual differences that impact on study orientation in mathematics and ultimate learner performance. Hence the researcher is therefore persuaded that through training in the appropriate knowledge, skills and use of volitional strategies teachers may be able to create a more favourable learning context in their classes that enhances study orientation in general, particularly in mathematics. Therefore there is need to integrate affective issues in the mathematics curriculum.

Words for indexing:

Mathematics education; teaching; learning; volitional strategies; learning context; study orientation; achievement; secondary school.

OPSOMMING

Die verband tussen leerderwilstrategieë, leerkonteks en die leer van wiskunde in graad 10

Dit is bekend dat die status van die onderrig en leer van wiskunde in Suid-Afrika substandaard is. Een rede vir hierdie probleem is die feit dat wiskundeonderwysers probleme ervaar om leerders behulpsaam te wees om vol te hou in hul leer-voornemens. Die redes vir die gebrek aan volgehoue leerintensie en die byhou by die onderrigplan kan nie aangespreek word tensy dié redes verstaan word nie. Derhalwe moet die probleem verstaan word en meer navorsing moet in hierdie verband gedoen word. Om daardie rede is hierdie studie gemik op 'n ondersoek na wilstrategieë, studie-oriëntering in wiskunde en die leerkonteks in verhouding tot prestasie in wiskunde.

Hiedie studie is gedoen in geselekteerde skole met 'n volgehoue goeie prestasie in wiskunde (matriekslaagsyfer > 80%) vir die voorafgaande drie tot vyf jaar, en in skole wat in dieselfde periode swak presteer het (slaagsyfer < 30%). Wiskundeonderwysers by hierdie skole is by die ondersoek betrek. Die resultate van die empiriese ondersoek het die teenwoordigheid aangedui van 'n sterk betekenisvolle verband tussen leerderprestasie en die gebruik van wilstrategieë en studie-oriëntering. Die toepassing van positiewe studie-oriëntering en wilstrategieë het gelei tot 'n verbeterde toeskryfbare gevolg op prestasie. Ook het hierdie studie getoon dat daar 'n sterk negatiewe korrelasie is tussen volgehoue emosionele inhibisie en emosionele nadenke, en 'n sterk positiewe korrelasie tussen die kontrole van mislukking en prestasie.

Hierdie studie toon ook aan dat daar 'n beduidende verskil is tussen studiemilieu en leerkonteks (soos aangetref in skole). 'n Matige verskil is opgemerk in houding, angstigheid, studiemetodes en inligtingverwerking tussen skole (as maatstaf van die leerkonteks). Die afleiding is gemaak dat die leerkonteks van skole studie-oriëntering matig tot sterk beïnvloed. Leerders met hoë prestasie het baat gevind by die bemeestering van aandag afleibaarheid, die kontrole van emosies, volgehoue emosionele

bepeinsing en stresvermindering, anders as leerlinge by ander skole wat die voorgaande nie kon toepas nie. Die afleiding kan dus gemaak word dat 'n geskikte leerkonteks die gebruik van wilstrategieë aanmoedig met gevolglike verbetering in leerderprestasie in wiskunde. Hierdie bevindinge is soortgelyk aan die van ander navorsers wêreldwyd.

'n Belangrike bydrae van hierdie studie is dat dit in 'n Suid-Afrikaanse konteks lig werp op die noodsaaklikheid van wilstrategieë en dat dit ook kontekstuele verskille identifiseer wat studie-oriëntering in wiskunde en uiteindelik leerderprestasie in wiskunde beïnvloed. Die navorser is daarvan oortuig dat deur opleiding in die toepaslike kennis, vaardighede en die gebruik van wilstrategieë, wiskundeonderwysers in staat sal wees om 'n gunstige leerkonteks in hul klaskamers te skep, wat weer tot verbeterde studie-oriëntering in die algemeen en in wiskunde in die besonder sal lei. Daar bestaan dus 'n behoefte om ook affektiewe leeraspekte in die wiskundeleerprogram te integreer.

Trefwoorde vir indeksering:

Wiskundeonderwys; onderrig; leer; wilstrategieë; leerverband/-konteks; studie-oriëntering; leerderprestasie; sekondêre skool.

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CHAPTER 1

INTRODUCTION AND ORIENTATION TO THE STUDY

1.1 INTRODUCTION

The grade 12 mathematics results in South Africa for the past five years have been indicative of the need for transformation of mathematics education and the training system in order to promote quality learning. In this construct we highlight the need to include somewhat neglected concepts about “self” which when ignored, act as barriers to mathematics learning that impact negatively on mathematics performance. It is worth noting that one of the critical outcomes endorsed in the principles of the National Curriculum Statement includes learners being able to organise and manage themselves and their activities responsibly and effectively (Department of Education, 2003: 8). Furthermore, the same National Curriculum asserts that mathematics enables learners to organise, interpret and manage authentic activities in substantial mathematical ways that demonstrate responsibility and sensitivity to personal and broader societal concerns (Department of Education, 2003: 50). Responsibility and personal concern are embedded in the self, hence the necessity to include volition during mathematics teaching and learning. In this empirical research the relationship between volition, learning context and mathematics learning will be investigated.

1.2 STATEMENT OF THE PROBLEM

The shift towards an outcomes-based school curriculum that emphasises the acquisition of knowledge and skill necessitates the need for more awareness and acquisition of relevant knowledge and skills by learners, particularly in mathematics. In South Africa, the persistent poor matric mathematics results are indicative of the poor level of knowledge and skill proficiency acquired in school mathematics. If learner perceptions especially towards mathematics learning and teaching are examined a better understanding could be obtained of the factors contributing to poor results. However Zimmerman and Risemberg (1997:110),

identify learner volition as a key self-regulatory process that influences performance proficiency, particularly in mathematics. As well Corno (1993:16) concurs that volition aids learning and performance. In this regard learner perceptions about execution of self-regulatory and voluntary actions during mathematics learning were examined (see table 5.10). Furthermore detective means were employed to check any significant differences between different learner group perceptions (see table 5.11).

Volition is an action control process that is post-decisional, self-regulatory and that energises the maintenance and enactment of intended actions (Corno, 1993). It is essential to assist learners who experience difficulty in keeping to learning agendas. Garcia, McCann, Turner, and Roska (1998:413) indicates that volition has direct impact upon goal-directed learning behaviour and mediates between the intention to learn and goal striving. Schunk (2000:395) concurs that volition mediates the relation between goals and the actions to accomplish them. Detailed analysis on volition is included in paragraph 2.5.2.

According to Corno (1993), volitional strategies refer to knowledge used to manage cognitive and non-cognitive resources for the purpose of goal attainment. The following are examples of such strategies: selective attention control, encoding control, information-processing control, and motivation control. To this list Dewitte and Lens (1999) add high action identity. Conscious use of encoding control that entails the mental planning of steps for completing tasks can assist individual learners in protecting their best-laid plans to keep up with teachers' agenda (Corno, 1989:14). The extended list of volitional strategies is given in chapter 3.

Volition is often considered useful in enhancing persistence in learning (Dewitte & Lens, 1999). When contextual factors distract learners from goals to complete mathematical tasks, they need means to optimise motivational power and the intent to pursue goals. Volitional strategies are such means. Employing a volitional strategy means to protect concentration and to direct effort in the face of personal distractions (Kuhl & Beckman, 1985). The school context may hinder or supports execution of such strategies and thus contribute towards how learner orients self to study (see paragraph 3.6.2.1). These strategies aid both learning and performance, in particular learners' study orientation in mathematics (Maree, Prinsloo, &

Claasen, 1997). The comparative analysis of how volitional strategies are used in different school contexts is given in chapter 5.

Within some context when learners are faced with subjective goals that compete with the intent to work and study, their attention is divided. However, learner tendency is to rather go for easy-going activities. Hence, volition is not only needed to persist in difficult tasks, but also to quit "drifting" towards easy activities (Dewitte & Lens, 1999). As learners immerse in plans for achieving goals, they maintain high action identity. This, according to Dewitte and Lens, (1999), comes down to reminding oneself of the outcomes of one's academic behaviour, performance self-talk and self-efficacy enhancement. Garcia et al. (1998:392), indicate that the positive effects of intrinsic goal orientation and self-efficacy of cognitive engagement are augmented by volitional control.

This study makes special reference to volitional strategies, study orientation and learning context. These are considered as possible causative variables (independent) that could inhibit or enhance performance and achievement. The dependent variable was performance in mathematics that was measured using mathematics content tests that were written during the normal teaching period.

Variables and definitions

Volitional strategy

In this particular research work volitional strategy indicates an individuals' expressed choice of will to manage a cognitive task for the purpose of goal attainment, for example the learners' self- expressed choice to complete mathematics homework before going to play with friends (see paragraph 3.2).

Study orientation (SOM)

In this research learning of mathematics in terms of study orientation in mathematics refers to learner outlook, applied learning techniques as well as prevalent circumstances that influence learners' assimilation of mathematics concepts and procedures (see paragraph 2.4.1).

Learning context

In this study learning context refers to the necessary circumstances in which mathematics learning is meant to occur. This includes the following aspect namely social factors, teacher, and language of instruction as well as cultural aspects. For example, learning context may be referred to as traditional teacher-centred or constructivist learner-centred (see paragraph 3.6.1).

Performance

Performance is reflected through marks in terms of achievement grades on written work or test marks.

This study analyses the constructs volition, study orientation and context through investigating performance and achievement in grade 10 mathematics classes in some selected schools in Rustenburg. From the preceding argumentation, the focus of the statement of the problem becomes broadly grounded within following questions.

Research question 1

How does the use of volitional strategies and learners' study orientation influence mathematics performance in grade 10?

Research question 1.1

Are there any significant differences in the perceptions of sampled groups from a study population with regard to volitional strategy use in mathematics in grade 10 and study orientation?

Research question 1.2

Are there any significant differences in the perceptions of sampled groups from a study population with regard to study orientation in mathematics in grade 10 as determined by learner performance?

Research question 1.3

Are there any significant differences in the perceptions of sampled groups from a study population with regard to volitional strategy use in mathematics in grade 10 as determined by learner performance?

Research question 2

How does the learning context in grade 10 mathematics classes influence deployment of learner volitional strategies and ultimate learner performance?

Research question 2.1

Are there any significant differences from a study population with regard to prevalent context in mathematics in grade 10 and learner performance?

Research question 2.2

Are there any significant differences from a study population with regard to learner perceptions about study orientation and prevalent context in mathematics in grade 10?

Research question 2.3

Are there any significant differences in the perceptions of two sampled groups from a study population in different learning contexts with regard to volitional strategy use in mathematics in grade 10?

Research question 3

Within the theoretical premises and the empirical results of this study, what recommendations emanating from volitional strategy use are proposed?

1.3 AIMS OF THE RESEARCH

The aim of the research was to investigate the learning of mathematics as exhibited by learner performance in grade 10 classes, with particular attention to the use of volitional strategies, prevalent learning context and study orientation.

The objectives of this study were to:

- a) Analyse learner perceptions towards study orientation of two sampled groups and relate to the volitional strategies learners use in mathematics classrooms.
- b) Determine the relative influence of study orientation on the learning and achievement in mathematics of grade 10 learners.
- c) Evaluate learners' perceptions of their volitional strategy use with reference to their performance in mathematics of grade 10.
- d) Determine the relative influence of context on study orientation
- e) Determine the relative influence of context on volitional strategy use.
- f) Identify and analyse the contextual characteristics necessary for good performance in some "successful" Grade 10 classrooms of mathematics.

- g) Make recommendations based on the findings of this study that will contribute towards suggesting suitable teaching-learning strategies to enhance mathematics learners' volitional strategies and ultimately their improved performance.

1.4 THE RESEARCH DESIGN

1.4.1 Literature study

An intensive and comprehensive literature study of the relevant literature was done to analyse and discuss the inter-relatedness of volition, learning context, and mathematics performance and study orientation. This research was supported by several theoretical and empirical studies undertaken by other researchers on mathematics learning, volition and study orientation as well as the effects on achievement in mathematics. A framework for volitional strategies and effective learning of mathematics was developed, using mostly primary sources.

The following keywords or phrases were used in searches of the ERIC-DIALOG, NEXUS and EBSCOHost databases:

Volition, learning context, will, achievement motivation, persistence, self-directed learning, mathematics learning, cognition, constructivism, attitudes, self-efficacy, teaching learning approach, self-perception, metacognition, performance.

1.4.2 Empirical Research

Under this heading the experimental design, population, the progress of the research and the statistical techniques were discussed briefly.

1.4.2.1 *Experimental design*

An ex-post facto design that combined quantitative and qualitative methods using a field survey was used.

The intent was to uncover possible cause-and-effect between volitional strategy use and mathematics performance. The field study research was done as data were collected directly from individuals in their natural teaching and learning environment for the purpose of studying interactions, attitudes and other characteristics of study orientation of individual groups.

1.4.2.2 *Target population and Sampling*

The research was conducted in four High schools in the Rustenburg district of the North West Province, a fast developing area. This district was selected on the grounds that the researcher worked in it, schools were easy to access and the distribution of questionnaires would not pose a problem. As the study of mathematics as an elective commences in grade 10, the target population consisted of all grade 10 learners and their mathematics teachers in the schools concerned.

A random stratified cluster sample of eight grade 10 classes was drawn as follows:

Stratum 1: Two classes each from two schools with a matric pass rate $> 80\%$ ($n \approx 181$)

Stratum 2: Two classes each from two schools with a matric pass rate $< 30\%$ ($n \approx 209$)

The four teachers involved were included for the purpose of making observations of their teaching approach and to capture the learning context in their classes.

1.4.2.3 *Research instruments*

The instruments used in this study were designed to capture the perceptions of learners using written questionnaires with Likert-type questions and lesson observations.

Two self-constructed mathematics tests were used to measure performances: one on selected grade 9 work and one on selected grade 10 work (see paragraph 4.4.3.1, Appendix A & Appendix B).

An adapted and modified Volitional Component Inventory (VCI) questionnaire with 263 items was used to measure the learner perceptions in the analysis of volitional strategy use during mathematics classes. The VCI focused on the constructs of:

Self-maintenance

Self-control or goal maintenance

Self-reflection

Inhibition of volitional competencies under stressful conditions

(See paragraph 4.4.3.4 & Appendix C).

A 30-item questionnaire adapted and modified from the Academic Volitional Strategy Inventory (AVSI) was used. The AVSI (modified and adapted) focused on the constructs of:

Self-efficacy enhancement

Stress reducing actions

Negative based incentives

(For further elaboration on the AVSI instrument, refer to paragraph 4.4.3.3 & Appendix D.)

The Study Orientation in Mathematics Questionnaire (SOM) with 92 items, developed and standardised by the HSRC for South African learners, was used to measure and analyse the perceptions of learners towards study orientation in mathematics learning in the sampled classes (see paragraph 4.4.3.2).

Lesson observations were made to capture the learning context in classes. The observation schedule included taking note of the following items: mathematics topic, lesson planning and objectives, homework check, learner participation and engagement, teacher assessment style, lesson conclusion, medium of instruction as well as the teaching style (see paragraph 5.2).

1.4.2.4 *Statistical techniques*

In accordance with the aims of the research, the following statistical techniques were used:

- 1 The use of quantitative techniques as outlined in section 5.3.1 employing descriptive data analysis that centre on

The Cronbach's Alpha coefficients.

Means of different dimensions of volitional strategies and study orientation and standard deviations.

Effect sizes (Cohen's d- values) to determine the differences of practical significance.

Inferential correlation statistics to relate the variables in answering research questions.

- 2 The use of qualitative techniques to analyse and identify the variables (see paragraph 5.3.2).

Assistance was procured from the Statistical Consultation Service of the North West University (Potchefstroom campus for CHE) in the processing and analyses of the acquired data.

1.4.3 Procedure

The research procedure was set out as outlined:

A literature review was carried out on volition and other related articles aimed specifically on self-regulation and self-control. Other articles on study orientation entailed improving performance in mathematics.

Adapted and modified instruments of measurement were used for descriptive data analysis to scrutinise perceptions of two sampled strata towards the constructs of teaching and learning mathematics but with special reference to volitional strategy use and study orientation in mathematics and performance in mathematics.

The nature of mathematics learning context was established through a literature review study. Lessons were observed to determine the nature of prevalent context in mathematics classes in the involved strata.

A Pre-test was administered to learners on grade 9 mathematics content and Post- test on grade 10 mathematics content after teaching and learning have taken place,

Some deductions from the analysis of the results of the empirical research were made about the role of volitional strategies in relation to context and mathematics learner performance.

Recommendations were made based on the volitional strategy used within the constructs of teaching and learning mathematics.

1.5 FIELD OF RESEARCH

The core of this research was embedded in the field of learning and teaching mathematics that considered some variables that could affect the performance in mathematics. The study was confined to the use of volitional strategies, learning context and study orientation in mathematics learners in grade 10.

1.6 THE ORGANISATION OF THE DISSERTATION

In this chapter, the layout of the study was presented within a framework that included introduction and orientation to the study, statement of the problem, the problem questions, the aims and the research design. Variables were identified and definitions given.

In chapter 2, the different mathematics viewpoints that influence mathematics teaching and learning were discussed. The chapters focussed on how study orientations in mathematics affect the way learners are oriented towards learning and influence mathematics performance. Secondly, the significant roles of volition during mathematics knowledge compilation and procedural knowledge as well as in skill acquisition were outlined.

In chapter 3 the need to tow effort load (volition) in order to bring about motion of a stagnant vehicle (mathematical learning) was established through means of volitional strategies that promote self-regulation and self-control in goal maintenance and self-maintenance to bring about mathematics learning. The volitional strategies were identified and their influence on mathematics learning implicated. The structural components of the social context that influence mathematics learning were identified. In addition, the influence of learning context on volitional strategies as used by mathematics learners was interpreted with reference to performance.

The research methodology including design, population and sampling was outlined in chapter 4. This was followed by an overview of measuring instruments as used in the survey and the detailed procedure to answer research questions.

In chapter 5 the report was profiled on monitoring of schools, data obtained were processed, recorded and then analysed. The description of the statistical techniques used in the research was made as results were further interpreted and findings recorded.

Chapter 6 focused on a summary of the theoretical and empirical findings together with the proposed recommendations and conclusion.

CHAPTER 2

MATHEMATICS LEARNING, STUDY ORIENTATION, VOLITION AND SKILL ACQUISITION

2.1 INTRODUCTION

Mathematics learning is a process influenced by which mathematics teachers conceive and ultimately convey to learners' views about mathematics nature. These conceived teacher notions and conduct in class are part of a context that dictates the instructional practice in which mathematics learning has to occur. Meaningful learning calls for effective sustainable instructional practices by both teachers and learners. The suitable context entails practices that stimulate learner effort. The eventual effectiveness of mathematics teaching and learning is measured by the output as displayed in learner performance. Effort is an indication of how learners wilfully manage, utilise self-resources and are able to take responsibility over their own learning and this is prescriptive of successful learning. In this construct we consider characteristics embedded within the individual that contribute wilful acts during mathematics learning. These learner resources referred to as volitional strategies should be of significant influence during mathematics teaching and learning. In addition, the social learning context is believed to have some bearing on the way the learner makes full use of his own volitional strategies.

Therefore, in this study attention is focused on the effect of learner use of volitional strategies, in particular learning context and on the learning of mathematics as determined by performance of grade 10 learners in mathematics.

This chapter firstly examines learning theories in order to understand mathematics learning and dynamic systems behaviour. Secondly, study orientation in mathematics is examined in order to have a comparative view of volition effect and its implications to mathematics learning. Thirdly, some overall view on volition and implications to mathematics learning are made. Fourthly, mathematics skill acquisition is expounded.

2.2 LEARNING MATHEMATIC AND DYNAMIC SYSTEM BEHAVIOUR

2.2.1 The instrumentalist and behaviourist learning views

The different mathematics views as held by teachers influence the practice of mathematics teaching and subsequently learning. The instrumentalist learning view as documented by Thompson (1992:132) denotes mathematics as a bag of tools made up of accumulated facts, rules and skills to be used by the trained artisan skilful in the pursuance of some external end. In terms of the stated view, mathematics only belongs to partisan groups who are intellectuals.

In line with the instrumentalist view is the behaviourist view of learning that considers mathematical learning the acquisition of ready-made algorithms and proofs through listening, memorising and practising, (Tamsin, 2002:169). This has the connotation that mathematics is a set of rules that require memorisation, with computation problems solved by using algorithms, where problems always have one correct answer, and people who use mathematics are geniuses (Bottge, 2001).

With reference to both views the teaching of mathematics is content focused with emphasis on performance and mastery of mathematical rules and procedures. Learners are to reproduce mathematics facts and procedures with or without understanding. During mathematics practice the proponents of these views do not put emphasis on understanding as they advocate that mathematical facts need only to be reproduced.

2.2.2 The dynamic problem solving view

The dynamic problem driven view considers mathematics as a continually expanding field of human creation and invention in which patterns are generated and then distilled into knowledge. According to this view mathematics is a process of inquiry, coming to know, adding to the sum of existing knowledge (Thompson, 1992:132). This is dynamic in the sense that cognitive thought actions are influenced in types of social contexts by, above all, affective factors like pride, mood, motivation and volition. Contrary to the views as outlined in paragraph 2.2.1, the dynamic problem views mathematics learners as being capable of inquiry if they make attempts and are involved in discovering mathematics knowledge. Teachers who advocate the problem driven view will, during mathematics instruction, cater for the affective factors in the social context.

2.2.3 Mathematics learning

Mathematics learning in accordance with the problem solving view involves creating awareness of some concepts, relationships and processes which, when need arises, can be extracted and applied. This aspect of creating awareness is also known as cognition and can lead to mathematics knowledge assimilation and acquisition. Mathematics knowledge as Bottge (2001) suggests includes knowing the number facts, computational algorithms and strategies for solving traditional text-based problems. Schoenfeld (1985:145) outlines that mathematics problem solving behaviour is based on knowledge of mathematical concepts and methods, knowledge of procedures, meta-cognition and learner view. It is apparent that part reproduction of some basic facts but with understanding is necessary for knowledge compilation. Thus the learning view is the determinant factor of the teaching approach that will facilitate effective mathematics learning.

Mathematics learning is seen as the process of acquiring a mathematical disposition or a mathematical point of view, as well as acquiring mathematical knowledge and tools for working with and constructing knowledge (Schoenfeld, 1992, 1994). Mathematics learning involves adding to the sum of existing individual knowledge. In mathematics learners use

encountered concepts to incorporate into new knowledge. Henningsen *et al.* (1997) indicate that having a mathematical disposition is characterised by such activities as looking for and exploring patterns in order to understand mathematical structures and underlying relationships. Hence sociable communicative skills are an added factor to make mathematical discoveries. In addition, available learner resources are to be used effectively and appropriately to formulate and solve problems, making sense of mathematical ideas, thinking and reasoning in flexible ways such as by conjecturing, generalising, justifying and communicating ones' mathematical ideas and deciding on whether mathematical results are reasonable.

2.2.3.1 Mathematics knowledge construction and context

The problem-solving view is expanded in the constructivist learning theory which holds the belief that meaning is generated by individuals by means of new experiences modifying existing patterns of thought and by responses formed by cumulative responses to previous experience (Von Glasersfeld, 1995, Stables *et al.*, 1999:449). In addition to the constructivist view, Rauff (1994) postulates that learners construct their own beliefs and knowledge of mathematics over time, and that these constructions are built upon a set of beliefs already held. Literature by Von Glasersfeld (1995) further maintains and substantiates that knowledge construction is made by selectively using experiences to create mental structures that form the basis of our knowledge. A cognising subject is actively building on that knowledge as learners are encountering perturbations. The implication is that knowledge is derived from interactions between persons and their context and as such reflects the outcomes of mental contradictions as a result of these interactions. The new experiences assist and shape mental structures according to opinions that have lately come to the fore. The context contributes in accommodating and reinforcing new concepts after voluntary selection of experiences is encountered.

2.2.3.2 Mathematics learning and emotion

Mathematics learning is appropriated when learners acknowledge and accept the problem as ‘theirs’. This, according to Stables *et al.* (1999:458), suggests learners have to be willing to pursue the task despite setbacks and to want to make sense of their results. Even though the teacher sets the initial task, emotional involvement with it leads the learners to pose questions of particular interest to them. However, observation of student learning from conventional instruction in mathematics according to Corno (1993:198), consistently shows inequities favouring those with a more general aptitude for mathematics, including a controlled and moderate anxiety level. By not paying attention to a “self” that determines problem acceptance during content knowledge in mathematics curriculum, emotional problems are overlooked hence instructions favour learners with more control over anxiety.

In pursuit of discourse on learner emotional control, Drodge and Reids (2000) define cognitive aspect of learning as a unified activity incorporating perceiving, emotioning, reasoning, acting and being. Literature documented by Bessant (2001) reaffirms that affective factors like emotions are involved in the most abstract form of intelligence. McLeod (1992:576) also suggests the need to integrate affective issues into studies of cognition and instruction. Affective domain entails beliefs, feelings, and moods, attitudes and emotions. McLeod further denotes that in the context of mathematics education feelings and moods like anxiety, confidence, frustration and satisfaction are all used to describe responses to mathematics tasks. Intrinsic and extrinsic interest or needs are observed factors that contribute as a learner solves an algebra problem.

Furthermore McLeod (1992:578) augments his ideas on affect in mathematics education by pointing out Mandler’s view that most affective factors arise from the emotional responses to the interruption of plans or planned learning behaviour. It is the evaluation of the interruption that is interpreted as a pleasant or unpleasant surprise, which fosters action. According to McLeod, cognitive evaluation of the interruption provides meaning to the arousal as they lead to positive or negative emotions. In order to avert disappointment in class, the inspiring sentiments when expressed by other learners and the teacher help shape individual learner’s

attention to monitoring of cognition in pursuit of goals. In co-operative mathematics learning groups a learner wants to act in expectation with group sentiments. Therefore, affect that is shown by sentiments in emotion and motivation influence cognition.

2.2.3.3 Mathematical learning and context

Kuhl (2000) postulates that the dynamics of systems interaction in successive learning involves implicating a conative cycle, the cognitive and affective systems. In the conative cycle the individual has desired to perform an action and therefore is sensitive to available opportunities for learning. Secondly, the individual with built-in and acknowledged self-esteem and confidence identifies and sets learning goals. Thirdly, the individual uses his own energy to initiate and implement plans and fourthly the individual acts persistently in pursuit of the set goal. The cognitive system entails attentive monitoring of available cognition, planning and problem-solving. The affective system requires attentive monitoring of available emotional and situational resources, effective self-management of emotional and motivational states and effective goal performance feedback. Therefore social learning context is of significant bearing to conative, cognitive and affective systems.

Moreover, previous studies in secondary schools in disadvantaged areas in the United States have revealed that the learning intentions and behaviour in lessons could be predicted from factors related to the classroom factors such as those embedded in social context (Norwich, 1994:1). The social context of the teaching situations, particularly the constraints and opportunities it provides, influences the practice of mathematics teaching (Thompson, 1992:131). It is outlined in literature by Halliday and Hasan (1989:5) and Atweh (1998:63) who hold that:

Learning is, above all, a social process ... knowledge is transmitted in social contexts ... and the words that are exchanged in these contexts get their meaning from activities in which they are embedded.

A teaching style leading to affective bias has risk factors with regard to adaptive control of behaviour, Kuhl (2000:689) attests. Even despite earnest attempts to remain faithful to a set-up of the task at the level of doing mathematics and teacher support of high level engagement, there is some notable decline by learners to unsystematic exploration. The decline could be attributed to lack of interest, motivation, knowledge or unclear task expectation, as observed by Henningsen (1997).

2.2.3.4 Mathematical learning and volition

Other dysfunctional patterns as displayed in procrastinators during academic settings were identified by Dembo and Eaton (1996). These demonstrated lack of conscientiousness associated with poor time management, work discipline, self-control, responsibility and under-arousal especially when deadlines approach. Harré (1983:259) and Stables (1999:451) emphasise the importance of self-knowledge, which they describe as 'a social process involving others in definite social relations to the person at the centre of the cognitive work'. It is this attributive factor of 'self' that makes its inclusion imperative to the learning of mathematics. The role of volition in moderating cognitive action when 'self' exercise will is essential to this study. Volition is of importance in developing student's thinking processes that are characterised by sustained progress in the development of meaning and understanding which leads to systematic exploration.

In sum, learning views on what teachers consider mathematics to be were made. These were namely the instrumentalist view, the behaviourist view and the dynamic problem solving view. The instrumentalist view mathematics learning as a process of acquiring a mathematical disposition, mathematical knowledge and tools for working with, in construction of knowledge. Only those who are geniuses can learn mathematics. In the behaviourist view mathematics instruction is content focused with the emphasis on performance and mastery of mathematics rules and procedures. In the dynamic problem solving view, mathematics knowledge construction is made by selectively using experiences to create mental structures that form the basis of new knowledge. The dynamic process involves the generating of patterns, which are assimilated into acquired knowledge and this is influenced by the social

context in which it occurs. Since learners who appropriate mathematical learning accept it as “theirs” there is a need for integrating affective issues into cognition and instruction. The affective factors that include moods, emotions, confidence, frustration and satisfaction can therefore be used to describe mathematics context. The listing of conative, cognitive and affective factors as identified by Kuhl was made. This dynamic interactive nature of mathematics learning includes the social context in which are embedded activities from which learners derive meaning. It is also mentioned that learners who are procrastinators display behaviour associated with poor time management, discipline, self-control and responsibility under arousal. Lastly, the need for volition input in mathematics learning has been suggested.

In view of the classroom based factors and affective factors that influence mathematics learning this research work intends to explore in greater detail the construct volition. The effect of learner use of volitional strategies, in particular learning context and on the learning of mathematics as determined by performance of grade 10 learners in mathematics, will be investigated.

2.2.3.5 Implications of affective factors to mathematics leaning

Affective factors such as interest, motivation, confidence and frustration need be given consideration during mathematics learning. There is a need for awareness of how learners control their attention, emotions, motivation impulse decision making and volitional self-confidence as they embark on self-directed learning behaviour. Of significance are promoting interests, ability to plan and self-determination. Affective factors as displayed in learning context contribute to dynamic interaction with cognition and influence performance in mathematics. Hence it is of significant value to integrate them in mathematics teaching and learning.

2.3 STUDY ORIENTATION IN MATHEMATICS

2.3.1 Definition of study orientation

In this research study, orientation in mathematics refers to learner outlook, applied learning techniques as well as prevalent circumstances that influence learners' assimilation of mathematics concepts and procedures. This includes circumspect learning techniques that facilitate learners' ability to become skill proficient (see paragraph 2.3.2).

2.3.2 Fields of study orientation in mathematics

The inherent classroom experiences determine study orientation. Maree *et al.* (1997:7-9) identify six fields of study orientation in mathematics. These are namely (i) study attitudes, (ii) mathematics anxiety, (iii) study habits, (iv) problem solving behaviour, (v) study milieu, and (vi) information processing. A diagnostic analysis of learner study orientation according to documented literature by Norwich (1994:4) unmask four distinct characteristics coherent with goals set. The four characteristics are outlined as follows; the first is task mastery orientation, wherein learners intend to learn as much as possible. The second is ego and social orientation, in which learners like to perform on par with others or better. The third is avoidance goal orientation whereby learners avoid coming into the limelight, and the fourth is past learning behaviour that implicates prior ability of the learner. These characteristics are integrated into Maree's six learning fields below. According to Maree, *et al.* (1997: 3) there is statistically significant association between aspects of study orientation in mathematics, and achievement. Du Toit, (1970) concurs and indicates that a summary of study habits and attitudes have a predictive value with respect to academic achievement.

2.3.2.1 Study attitudes to mathematics

As documented by Maree *et al.* (1997), learners' study attitude can be regarded as the driving force behind their study attitude to mathematics. In a study of standard 10 students in South Africa, significant correlation between attitudes towards mathematics and mathematics scores

was observed (Galagedera *et al.*, 2000:681). Attitudes include learners' mathematical worldview about the self, the nature of mathematics and the nature of learning mathematics. In addition, study attitudes have relations that affect learners' motivation and expectation with respect to learner interest in mathematics. Consequently such dispositions include various factors like enjoyment of mathematics, self-confidence, usefulness of the subject and the challenge it offers. Learners even display a change in attitude with unwillingness of attempting to try. When given homework they copy from others without having attempted it on their own. Learners who reputedly prefer being smart display avoidance behaviour as they protect the ego when encountering challenges during mathematics activities. Such learners do not individually participate in class discussions but shield behind class group responses. This dodging type of learner behaviour affects cognitive engagement and eventual performance.

2.3.2.2 Mathematics anxiety

Mathematics anxiety involves the domain that includes panic and concern as manifested in the form of aimless repetitive behaviour like an exaggerated need to visit the toilet, scrapping of correct answers and an inability to speak clearly. Learners' motivation in mathematics is affected negatively when they are emotionally disturbed. When pupils have not adequately mastered the limited technical language of mathematics, when challenges exceed acquired skills and even after failure, mathematics learner anxiety prevails. Anxiety interferes with cognition and skill execution. Drodge and Reid (2000) emphasise the significance of emotional orientation impacting on learning mastery during mathematical activities. When learners are too afraid to discuss their problems with teachers or even to ask questions this inhibits learner's risk-taking disposition in mathematics and their cognitive functioning is delayed.

2.3.2.3 Study habits useful in mathematics learning

Maree *et al.* (1997) indicates the potential of learners to display acquired consistent study methods and habits like planning time and preparation, and working through more than just familiar problems. Corresponding to study habits, learners exhibit a willingness to not only

gain insight into certain aspects of mathematics but also to learn theorems, rules and definitions properly and carry out assignments on mathematics in a focused manner. This is in accordance with the view that learners with a task mastery orientation exert more effort on their learning as they exhibit strategies and are able to endure even in the presence of competing challenges. According to Schunk (2000:411), mastery approach can build learners' self-efficacy for learning which leads to learners' belief in for further learning being enhanced. Learning task as well present competitive situations in which learners' existing abilities and skills are challenged. Success in mathematical challenges demands execution skills that lead to problem mastery. Effort, as Kanfer (1989: 381) proposed, entails executive processes that protect, sustain and guide attention to tasks.

Secondly, learners with appropriate study habits promptly complete assignments and tasks in mathematics. They keep homework up to date and avoid wasting time. Learners employ effort that plays a significant role even during anxious mathematics moments involving on-task and off-task activities. It is attention effort, that according to Kanfer and Ackermann (1989:661), competes with on-task and off-task demands of self-regulatory motivational processes.

Thirdly, study habits Maree *et al.* (1997) claim entails the willingness to do mathematics consistently, in spite of the fact that other more attractive "nicer" activities could have been done instead. This upheld view is in line with Confucian Heritage Culture as documented in literature by Wong (2002:214), which indicates that the salient characteristics of learning as social achievement orientated with emphasis on diligence, attributing success to effort, and a competitive spirit. In social learning contexts, learner orientation is influenced by variables such as learner competition. The desire to out perform others points in the direction of more effort applied to learning. According to Schunk (2000:353), social comparisons with others are important sources of information to form outcome and efficacy expectations. In addition to list factors, the will to achieve better than peers also has a bearing on study orientation.

Literature reveals that consistent task practice is associated with higher levels of performance and decreasing demands on attention (Norman & Robrow, 1975; Kanfer & Ackerman 1989: 660). Wong, (2002:213) concurs and illustrates further the practice in conceptions of doing

and learning mathematics by quoting the Analects of Confucius 'learn and practice frequently'. This, as Wong demonstrates, implies that continuous practice with increasing variations could deepen understanding. The role of volition in reinforcing practice and further attribution of effort as determined by study orientation in mathematics is discussed in chapter 3.

2.3.2.4 Problem solving behaviour

Maree *et al.* (1997) documents that this aspect of study orientation includes planning, self-monitoring, self-evaluation, self-regulation and decision making during the process of problem solving in mathematics. It also includes strategies like searching for patterns and relations in mathematics, the ongoing testing, estimating and approximating of answers, abandoning strategies when they do not work in favour of trying alternative strategies. Mathematics skill proficiency entails a regular problem solving culture. Study orientation in mathematics significantly influences problem solving abilities and eventual achievement.

The problem solving approach as Agran *et al.* (222:287) purport represents a validated student friendly strategy that provides students with an opportunity to exercise choice and control over self-selected instructional and learning supports. The inadequacy experienced by some learners and teachers in making use of and deficient knowledge of appropriate learning skills contributes to some non-uniform approach tendency to mathematics. The irregularity in attending to mathematics core and the non-problem solving approach also have an effect on how learners are inclined to subject mathematics. It is in this regard that Maree *et al.*, (1997: 7) consider the problem-solving context as the primary premise of the study orientation in mathematics as opposed to merely memorising rules, theorems and principles. In addition, by becoming more effective problem solvers, students are better able to set and attain goals, identify potential response alternatives in the decision-making process, and self-regulate learning (Agran *et al.*, 2002:280).

2.3.2.5 Study milieu

In this field, as Maree *et al.* (1997) postulates, non-stimulating learning and study environments, frustration, restrictive circumstances at home, names and life styles as used in word problems that do not come from the learners' field of experience and language problems are limiting, confuse learners and undermine performance in mathematics. The second language problem, which is restrictive and milieu deprivation often lead to mathematics anxiety, undermine learner self-confidence and inhibit mathematics achievement. Language as used in mathematics is used differently from that used in everyday life (see chapter 3 section 3.6.4.5.1).

2.3.2.6 Information processing

Information processing entails the use of learning strategies that include those of summarising and reading, critical thinking and understanding which involve optimum use of sketches, tables and diagrams. The field provides some measure of the extend to which pupils really understand mathematics. Information processing and ability demand change as a function of practice, training paradigm and timing of a goal setting (Kanfer & Ackerman, 1989:657).

Tamsin (2002:170) posits that the most appropriate entry into an idea depends upon student background which consist of both their previous schooling experiences and also their outside schooling experiences. The more connections that are made between different kinds of knowledge, the more likely the understanding of all those ideas would improve. The understanding that children bring to the activity are the ground from which learners create particular goals (Saxe, 2002). Study orientation should elicit past learning behaviour that implicates prior ability of the learner.

In conclusion to this section (2.3), types of study orientation in mathematics have been highlighted as collectively determined by a number of listed factors. These are learner attitudes and avoidance behaviour with regard to mathematics, as well as anxiety and motivation. Study habits are included as a factor wherein learners display acquired consistent

study methods and habits like planning time and preparation as well as the willingness to do mathematics consistently, in spite of the fact that other more attractive “nicer” activities could have been done instead. There is also a factor that involves planning, self-monitoring, self-evaluation, self-regulation and decision making during the process of problem solving in mathematics. Study milieu is hinted at as a factor that entails non-stimulating learning such as study environments, frustration, and restrictive circumstances at home. The other factor is information processing that entails the use of learning strategies including those of summarising and reading, critical thinking and understanding. In addition, information processing encompasses learners’ optimum use of sketches, tables and diagrams. All the listed factors have some significant association between aspects of study orientation on the one hand and mathematics achievement on the other.

2.4 THE SIGNIFICANCE OF VALUES AND BELIEFS AND THEIR EFFECT ON STUDY ORIENTATION IN MATHEMATICS

2.4.1 Definitions

Value as used here refers to individuals’ expressed desirability to be involved in mathematics activities as a result of believed purposeful influence the subject has in line with intended career choice (see paragraph 2.4.2).

Belief as used here implies individuals’ expressed opinion concurring with confidence that leads to action (see paragraph 2.4.3).

2.4.2 Values’ influence on study orientation

It is noted in documented literature by Seah (2002:190) that the discipline of mathematics is increasingly recognised as socialised knowledge developed in response to human needs. Embedded within the discipline, according to Seah, are underlying cultural values, beliefs, attitudes and assumptions. Successful conveyance of mathematics values is reflected on

attention spent by learners on the subject. Valuing is a highly cognitive activity that involves activities of choosing, prizing and acting (Rath. *et al.*; Seah, 2002:191).

During mathematics learning it is the teachers who knows the value of regular exercise that will daily assign work to their learners. The values related to mathematics education are inculcated through the individual's experience in the mathematics classroom and in the socio-cultural environment. Seah (2002:192) attests that:

Personal value system equips with cognitive and affective lenses to shape and modify way of perceiving and interpreting the world and to guide learner choice of course of action.

The perception of mathematics as a highly instrumental subject impacting on learner careers imposes purposeful effect and affect on its learning. The enhanced perceived value of learning strengthens intrinsic motivation to learn (Schunk, 2000:352). Learners are able to make the necessary adaptations during mathematics activities according to the significant value attached to the subject. In addition, teachers who set a high value on time to correct learner exercises timely thus provide feedback to learners before they lose interest. Value as placed by the institution and parents are demonstrated in time allocation, teacher dedication, availability of resources and support provided for the subject. Emanating from implicitly developed values is the commitment that should be displayed plus the degree of engagement and responsibility by the learner. The values influence and reinforce the belief system. Seah (2002:191) suggests values to be indicators of beliefs and attitudes.

2.4.3 Beliefs' impact on study orientation

Student beliefs about mathematics and about themselves play an important role in the development of their affective responses to mathematics situations (Mcleod, 1992:578). Ernest (1988) identifies the system of beliefs by teachers concerning mathematics and its teaching and learning as a key element that influences the practice of mathematics teaching (Thompson, 1992:131). During the conjecturing phase of mathematics learning before learners can

generalise and justify, beliefs are of significance. Beliefs regulate how learners become orientated towards risk-taking, how they make intelligent guesses or even hypothesise without fear of failure. Beliefs are directional during learning as individuals with strong beliefs increase and concentrate their effort towards attainment of a goal. Belief in efficacy of one's effort mediates approach and engagement patterns (Ames, 1992:268). As documented by Zimmerman and Risemberg (1997:115), learners who believe that their level of performance is linked to their amount of effort, in fact utilise learned strategies more often than learners who do not hold these beliefs.

In addition, Mcleod (1992:581) substantiates that beliefs provide an important part of the context within which the emotional responses to mathematics develop. Trust and confidence accompany beliefs. Kuhl and Fuhrmann (2000) assert that self-confidence is based on beliefs about volitional control. Learner persuasion on mathematics activity is determined by own beliefs. Documented Literature by Mcleod (1992:580) expands and is more comprehensive about the individual as noted that beliefs about self are closely related to notions of metacognition, self-regulation and self-awareness. Learners' failure to solve mathematical problems is directly attributable to their less powerful beliefs about the nature of mathematics and mathematics problem solving (Schoenfeld, 1989).

2.4.5 Summary and implications of values and beliefs to mathematics learning

In summary, values are of significance to mathematics learning as they influence study orientation. Values have been described as being cognitive and affective activities, which are involved in choosing, prizing and acting. Values modify the way of perceiving and interpreting the world as they guide the learner choice of action and as well values influence the degree of engagement and responsibility by the learner.

It is alluded that learner beliefs about the nature of mathematics and about themselves influence development of affective responses to mathematics situations. From beliefs develops trust and self-confidence. The belief in the efficacy of one's effort mediates approach and is related to notions of meta-cognition and self-regulation.

The implication is that learners who put a high prize tag on mathematics indicating their valuing the subject are more likely to display task mastery orientation. There is a need to integrate value systems into mathematics teaching. If learners are orientated into a career choice from the early stages of their learning the significant role of mathematics is highlighted early. This has a purposeful influence in its learning. It is necessary to include in the mathematics curriculum and teaching the awareness of careers involving the subject.

A belief system as indicated is instrumental to an individual's development of trust and confidence. The amount of effort one puts into it is directly related to how pupils view themselves as being capable. It is therefore important that learners are aided to develop a self-image that portrays self-appreciation with dependability on effort. Thus, even when learning is as noted oriented towards continuous practice, learners will not feel burdened. Encouragement emphasising reliance on effort has implications for the teacher in inculcating an environment in which learners' belief and know that it is diligent hands that bring success. It is therefore of great importance that teachers are involved in assigning daily mathematics homework, class practice and regular tests while learners are devotedly committed towards positive and honest engagement.

2.5 VOLITION

2.5.1 Introduction

The individual's mind frame is of worth in interpreting how individual learner approaches work on and become committed to mathematics learning. The self is regarded as a causal agent in regulating behaviour in a variety of social contexts. Teo and Quah (1999:25) suggest in this regard that knowledge of the self, volition, personal and interpersonal skills, wise and prompt actions are necessary and sufficient conditions for growth and achievement. Volition as explained by Ginnet and Hinton (2001) refers to mental events that mark off actions from non-actions. The honour lies with the individual to choose between action and inaction when

assigned with mathematics learning tasks. James (1981) designates volition as a relation between ourselves and our state of mind. Action orientation forms the core frame of volition.

2.5.2 Definition and the construct volition

In this study we adopt the documented outlook by Garcia *et al.* (1998:393) that define volition as those thoughts and / or behaviours that are directed towards maintaining one's attention to attain a specific goal in the face of both internal and external distractions.

Mathematics learning demands some discipline that is regulated by an individual's state of mind. The degree to which the learner is accustomed to mathematics learning trait is influenced by the learner affect and the value placed on mathematics. Positive affect promotes interest and facilitates intentions (Kuhl, 2000:667). Volition is that electric connection emanating from the self and connecting the self to the intention (Teo and Quah, 1999). According to Garcia *et al.* (1998) the influence of motivational processes on cognitive engagement is enhanced when volitional strategies are employed.

In classes where there is some tendency for teachers and learners to approach mathematics in a non-uniform way, the use of psychological processes capable of directing and controlling cognition is necessary. According to Corno (1993:19), volition involves psychological processes that energise the maintenance and enactment of intended actions. Garcia *et al.* (1998:400) assert that such processes protect intention to learn against enticing temptations and alluring temptations. The means by which enticing and alluring temptation are overcome are achieved as Corno (1993) expands it through implementation of volitional resources. The resources herein referred to as volitional strategies help individuals to direct and control their cognition, motivation, and emotion when faced with competing goals and other information processing intrusions. Administration of rewards is an example of motivational control strategies.

Corno further attributes volition to mobilising and maintaining strategies that get the most from an information processing system. Kanfer (1989) posit volition as the individuals' wilful

allocation of attention cognitive resources to a particular goal. Kuhl (2000:667) in his personality systems interaction theory, suggests that the effectiveness of motivation and self-regulation can be influenced by the relative activation of cognitive macro-systems as modulated by affect. The macro-systems are enlisted as (1) analytical thinking and a memory of explicit intentions, (2) holistic feeling and a memory for extended semantic fields, (3) intuitive behaviour control, and (4) sensitive recognition of objects. Kuhl assumes that the macro-systems participate at various levels in information processing. Positive affect produces behavioural facilitation. Learners are inclined to spend more time working on what they enjoy and know they are likely to benefit. Thus affect leads to volitional facilitation when explicit intention is formed and maintained in intention memory, Kuhl indicates. Enjoyment and envisaged benefits are intentions that keep one in action. Kuhl and Fuhrmann (1998:18) suggest that positive and negative emotionality can be understood in terms of the sensitivity and activation strength of motivational reward and punishment systems evoked under stressful conditions. If a social context outlook is more reward prone, positive emotions are dominant and these lead to mobilising and maintaining learning strategies.

Turner *et al.* (1998:768) indicate that affect plays an important role in the implementation of motivational goals. Dembo and Eaton (1996:98) give the example that substantiates the affect that student's motivational beliefs and emotions mediate between their cultural and classroom experiences and behaviour. Learners who learn to value mathematics content are intrinsically motivated to increase their skills and abilities in it; they achieve cognitive objectives (Cangelosi, 1996:170). According to Kuhl (2000:661), the different ways that persons regulate affect and their self-regulatory styles form the volitional core of personality. An expansion on the affective role of volition on motivation and emotion control is given in chapter 3, sections 3.4.1.2 and 3.4.1.3.

2.5.3 Volition and affect reassuring self-confidence in mathematics

The imposition of attitude in determining learner tendency under some mathematics constraints is of considerable value to understanding cognitive responses. Maree *et al.* (1997:7) indicate that self-confidence, usefulness of the subject and the challenge it offers can be regarded as the

driving forces behind study attitudes to mathematics. Thus learners' affective disposition influence their attitude towards mathematics. Volition governs attitude by intensifying meaningfulness of given actions in terms of conceitedness and so promoting self-confidence towards skills deployment.

Kuhl and Fuhrmann (1998:15) also attest that volitional processes have to be seen in conjunction with processes relating the "self", that is the integrated and implicit representation of a person's experiences, beliefs and needs, to individual goals and other expectations. Biased activation of affect in relation to key cognitive systems can lead to inflexible cognitive and self-regulatory styles (Kuhl, 2000:666). In this respect Corno (2000: 659) suggests that volition entails plans to sustain motivation and implement goals, along with strategic regulation of cognition and affect in the completion of tasks. Garcia *et al.* (1998: 413) indicate that volition control protects one's intention to learn by amplifying the effects of motivation on the use of learning strategies.

Rewards reinforce self-confidence. Cangelosi (1992:78) asserts that in the affective objective of appreciation, learners achieve an objective at the creativity learning level by believing that the mathematical content specified in the objective has value. Winne and Marx (1983: 254) concur that learners' work at tasks is governed by a goal that the students perceive about the task. According to Cangelosi (1992:169), achievement of an appreciation level objective requires students to hold certain beliefs but does not require them to act upon those beliefs. Volition facilitates the enactment of intentions that are incompliant with the expressed beliefs, thus reassuring self-confidence.

2.5.4 Negative emotions as signal of volitional need in mathematics during conjecturing

Research as documented by Norwich (1994:7) indicates that pupil orientation to avoid work and their perceptions of obstacles to their learning were high as well while perceived pressure to learn from friends was low. This is despite attitudes and feelings about learning mathematics being positive, goal orientated and perceived pressure from adults to learn mathematics is high. Avoidance behaviour can be explained with reference to internal

structure of individuals. Interpreting emotions within a social context of the classroom can provide a framework that may be used to analyse an individual's internal functioning, Bessant (2000) postulates. Emotions are socially conditioned and acquire cognitive and linguistic interpretations that determine the extent to which an individual can withstand perturbation during mathematics activity. Drodge and Reid (2000) assert that emotions play a positive and central role in mathematics since it is through social discourse that people become mathematicians.

Emotions as indicative reaction to perturbation lead to the concept of emotional orientation. This in terms of explanation, as provided by Drodge and Reid (2000), refers to culturally defined and recognisable patterns of individuals relating to each other that include shared beliefs, values, and ways of communicating and forms of acting. Furthermore the same literature identifies three linked functions that influence mathematical emotional orientation as:

1. The criteria for accepting explanations;
2. The activities that are considered appropriate; and
3. The shared experiences and assumptions of a community.

Emotional orientation affects the way mathematics activity is observed during conjecturing. A conjecture involves testing a proposition to discover some relationship. Documented literature by Polya (1954 & 1990), Debellis and Goldins (1999) and Drodge and Reid (2000) reveals that conjecturing involves three phases namely:

- 1 Intellectual courage that entails an ability to make conjectures which require revision of one's beliefs
- 2 the willingness to revise conjecture in the face of a contradiction, and
- 3 Wise restraint that is the recognition that some conjecture such as verbal intimidation is not appropriate mathematical behaviour and should not undermine the conjecture.

In mathematics settings examples of emotional orientation would be:

- 1 Desiring precision;
- 2 Desiring explanation in the face of lack of understanding;
- 3 Valuing patterns; and
- 4 Wanting to make connections between existing knowledge and new conjectures.

Learners who view learning tasks as opportunities to acquire new skills and abilities as Cangelosi (1996:8) suggests, are willing to pursue even perplexing tasks and to learn from their mistakes. Turner *et al.* (1998:769) add that students who regard errors as informational are able to adjust skills upward by changing strategies and are thus able to approach challenges successfully. Action orientation is associated with greater control over emotion (Menec & Schonwetter, 1994:10). Pupil motivation in mathematics is affected negatively when they are emotionally disturbed. Fear and own judgement distract from correct skill execution. Turner *et al.* (1998:761) postulate that emotion is crucial in directing the patterns of cognition, motivation and self-regulation. Research work by De Witte *et al.* (1999: 7) indicates that emotional regulation may be positively related to performance for test-anxious learners. Kuhl and Kraska (1989) demonstrate a negative correlation between emotion control and fear of failure. According to Turner *et al.* (1998:758), negative affect after failure mediates positive performance goals and self-regulatory beliefs and behaviour.

The emotional liability in mathematics class inhibits risk-taking attitudes in mathematics and as a result learner cognitive functioning is delayed Maree *et al.* (1997: 7). When challenges exceed skill acquired learners feel anxious and become state-oriented; consequently they allocate attentional effort towards emotional concern. This disrupts mapping of distal resource allocation, Kanfer and Ackerman (1989:661) assert. The choice to engage any, some or all of one's resources for attainment of a goal is termed distal motivation process, according to Kanfer and Ackerman. The choice to engage moderates allocation of on-task effort. Emotion is a source of motive forces that propel student into action as well as to sustains or diminish the dominance of primitive motivational content in working memory (Winne & Marx, 1983: 245). According to Corno (1993:15), volition directs and controls intellectual, emotional and behavioural energy toward academic goals that are subjectively difficult to enact. The

management of emotion and attitudes involves the use of volitional strategies (Garcia et al. 1998, Kuhl, 1985). Emotion highlight the importance of goals and prompts a coping mechanism designed to protect and enact goals (Turner *et al.*, 1998:761). Emotion acts as a signal with diagnostic influence on practice inhibition or exhibition by emphasising the significance of goals. Goal significance has an effect on cognition.

2.5.5 Volitional effect on self-regulation during mathematics learning

When an intricate learning task challenges the abilities and skills in mathematics, learners who willingly pursue and persist are more probable to keep on the learning tract. Complex or novel mathematics tasks require sustained attentional effort. Cangelosi (1992:51) ascribes confidence and willingness to pursue solutions to problems as a requisite attitudinal skill to problem solving. Willingness to act leads to a tendency to attempt and is an affective aspect of self-regulation. According to Corno (1993) and Garcia (1998:395), it is volitional control that maintains the attempt to learn.

Self-regulatory abilities support affective change in learning (Kuhl, 2000:665). It is well documented by Kanfer and Ackerman (1989:686) that self-regulation processes are to be viewed in two perspectives firstly as comprising cognition about one's abilities, effort and functioning and secondly as strategies for control over one's cognitive activity.

In volition control the individual plays a causal role with causal influence in the direction of the intention by the individual (Teo & Quah, 1999). Karoly (1993), who even designates volition to denote capacity for self-regulation, acknowledges this fact. Moreover volition, according to Oka (1994) and Teo and Quay (1999), is the ability to maintain and enact intentions in the face of competing action alternatives. However, Kuhl and Fuhrman (1998:15) subsume self-regulation as that mode of volition supporting the task of maintaining one's action in line with one's integrated self. Self-regulation processes of strategy use and adaptive efficacy beliefs are important for steering and controlling performance (Wolters & Pintrich, 1998:45). In mathematics learning, self-regulated learners employ their volitional skills to successfully embark on new topics with the minimal help from teachers and have control over

their work. Teo and Quah (1999:26) also attest that volition is the motive power that generates, propels and fuels the actions and deeds intended by the self.

In this section volition has been defined as thought processes that direct and maintain attention to attain a specific goal amidst internal and external distractions. It is indicated that volitional strategies help individuals to direct and control their cognition, motivation and emotions when learners are faced with competing goals and other intrusions in the mind. The role of positive affect in leading to volitional facilitation that gets the most from information-processing system was discussed. It was illustrated how volition inconsistent with belief systems promotes self-confidence that in turn leads towards skill deployment.

The fact that emotions determine the extend to which an individual can withstand perturbation during mathematics learning has been termed emotional orientation. The following were linked to emotional orientation: how learners accept explanations, activities that are considered appropriate, and the shared experiences and assumptions of a community. It was further demonstrated to what end emotional orientation affects how mathematics activity is observed during conjecturing. It is significantly important to control emotions, as it is believed that they distract learners from skill execution. In this construct it is believed that negative emotions signal the need to deploy volition which in turn directs and controls intellectual, emotional and behavioural energies. In supporting the task of maintaining one's action in line with one's integrated self, volition subsumes self-regulation.

2.5.5.1 Volitional effect on cognition

Mathematics learning entails problem solving. A conceptual level of understanding of the mathematical concepts, relationships and processes is a requisite skill to problem solving (Cangelosi, 1992:51). In addition, concept acquisition is an essential prerequisite for learning advanced work in mathematics (Maree *et al.*, 1997:3). A deficiency of mentioned skills contributes to learners' dodging or cheating. Learners who mimic in class and pretend to know are more oriented to ego protection than to learning and improvement. Such egocentric learners should benefit from volitional use. Research by Garcia *et al.* (1998:392) indicates

that the positive effects of intrinsic goal orientation and self-efficacy on cognitive engagement are augmented by volitional control. This is incongruent with the perception held by Teo and Quah (1999) that volition is a human attribute which bridges the gap between thought and action as it mediates knowing and action.

According to Garcia *et al.* (1998:393), volitional control strategies are strongly related to the use of cognitive strategies for learning as they help to maintain goal directed activity. In the same literature by Garcia *et al.* (1998) it is concluded that volition plays a mediating role between the intention to learn and the use of learning strategies. The view is backed up by Corno (1993:19) who reiterates that volition supports important aspects of cognition such as depth of processing information. Research as documented by Dewitte and Lens (1999:6) likewise reveals that deep-level processing mediates the interaction between procrastination and the use of volitional strategies and performance. Volitional control strategies are necessary especially during problem solving as structural conventions that provide a means for organising, retaining and relating mathematics that requires sustained attention effort.

2.5.5.2 Volition in support of mathematics learning

It is documented that volitional control represents a broader range of regulation than meta-cognitive control. This is reflected in the fact that volition involves learner activation, allocation, and maintenance of a variety of psychological resources in order that goals and the means for attaining them can become and remain focal (Corno, 1993:17). Additionally, volition as well encompasses plans to sustain motivation and implement goals along with strategic regulation of cognition (Corno, 2000: 659). The facilitative effect of volition in the maintenance of motivation engages attention on the implementation of difficult intentions.

In substantiating Gollwitzer's theory on goal implementation, Corno (2000:662) postulates that goals are more effectively attained when the person plans when and where to initiate goal directed actions. Goal implementation strategies have significant implications to mathematics problem solving that necessitates an approach outlining planning, monitoring and evaluation. At this juncture we make an analogy that in sustaining motivation and regulating cognition,

volition acts in a similar manner as a supportive automobile jack or tripod stand during wheel change that suspends car mass. When mathematics tasks require learners to handle multiple goals over long stretches of time, volitional control is also needed. While working on mathematics projects learners may still be expected to fulfil other tasks like having to read set books or to continue on different section in mathematics.

The realisation of mathematics' contributory role in one's intended future career impacts on learner attitude and a commitment level towards it. The concentration depth and time on task engagement are dependent on intended decision and action by an individual. Volition supports the perception that the tasks in which learners are engaged are instrumental in reaching their future goals (Corno, 2000:663). It is the learner's choice to indulge in deployment of helpful learning strategies and skills. Menec and Schonwetter (1994:6) connote that success orientation is related to confidence in having the ability to do well, and being willing to expend the necessary effort. The decision pertaining to mathematics and ability perception impounds on effort execution.

Task engagement and timely task completion are important outcomes of the task management aspect of volition. These attempts by the learner to protect concentration and to direct own efforts are volitional. According to Corno (1993:16), effort direction in the face of personal and environmental distractions aid learning and performance. De Witte *et al.* (1999:1) add that volition is needed to persist in difficult or unattractive activities and to quit easygoing activities.

Learners who are ill equipped in coping with failure should profit from the use of volition. Kuhl and Fuhrman (1998:43) suggest that volitional competence needs to be accessed under conditions of stress or frustration to avert failure. Included as well are learners who may be sufficiently motivated and have the intellectual ability but are not implementing appropriate successful learning strategies. Furthermore De Witte *et al.* (1999) document and advocate volition use by procrastinators a common tendency amongst learners to postpone attempts at mathematics homework or even to postpone test preparation to the last minutes.

2.5.6 Conclusion and implication of volition to mathematics learning

In conclusion, literature reviewed indicates that volition mediates between knowing and action. Therefore volitional control should positively influence cognitive engagement and strategic regulation of cognition. Mathematics learners are to benefit from volitional strategy use.

Volition mediates between the intention to learn and the use of learning strategies. As in sustaining motivation attention, effort is increased on the implementation of difficult learning intentions. Therefore, in pursuit of goals, persistence and goal implementation strategies affect mathematics problem solving that entails steps of planning, monitoring and evaluation. Other learning strategies involve depth of information processing whereby literature review suggests, procrastinators benefited from volitional use.

A review of literature is suggestive of the volitional role in effort direction in the face of personal and environmental distractions. The effect of volition on effort direction and attention should lead to action needed by the mathematics learner in order to carry through intended decisions. Volition control even ensures that decisions are sustained over an extended period despite any distractions. Mathematics learners who employ volitional strategies should take more responsibility in managing their own learning.

Literature review also well reveals that volition is necessary for learners to cope under stress or frustration and can contribute in the reduction of anxiety so that those learners avert failure. Mathematics learners should benefit from volition while learning and during test taking.

2.6 THE ROLE OF VOLITION IN MATHEMATICS KNOWLEDGE CONSTRUCTION AND SKILL ACQUISITION

2.6.1 Volition during mathematics knowledge acquisition

Mathematics content knowledge comprises discoverable relationships, conventions and algorithms. These concepts constitute the cornerstone of mathematics knowledge. Cangelosi

(1992:84) suggests that learners need access to a conceptual level of understanding during mathematics problem solving. When conceptualisation is incomplete pupils do not understand the relation between concepts. They use theorems and formulas without thinking whether they are applicable to the situation concerned (Maree *et al.*, 1997:4).

Kanfer and Ackerman (1989:660) describe skill acquisition in terms of three phases, namely the declarative phase, the knowledge compilation phase and the procedural knowledge phase.

Declarative knowledge is defined as knowledge about facts and involves requisite memory and reasoning processes. It forms the basis for learner attention to understanding mathematics conventions and executing algorithms. Bottge (2001) indicates that declarative knowledge is a representation of basic mathematics facts in a network pool, for example

$$2 + 7 = 9 \text{ or } 9 - 2 = 7.$$

These facts are retrieved when a situation calls for them. According to Kanfer and Ackerman (1989:660), the declarative knowledge phase is the skill acquisition learning phase in which learners may observe demonstrations of tasks, may encode, and may store task rules and may derive strategies for the mathematics task at hand. Learners devote their attention to understanding and performing the task. Inclusion of a secondary task interferes with devotion of attention and the learning of the task simultaneously. However, cognitive engagement requires attentional effort which may compete with on-task and off-task demands. James (1981:1166) and Hinton (2001) characterise volition in terms of attention with effort as a strain of attention that we experience when we choose between competing courses of action. Experience of will can be created by the manipulation of thought and action (Wegner & Wheatley, 1999:480). Thus, by choosing to pay attention to some demonstration, the mind imprints the process, which through help of the motor co-ordination centre can be reproduced. Volition that as the tendency for an individual to focus attention helps direct attention effort and keep one cognitively engaged. When an acquired fact is reproduced voluntarily, an individual is said to exercise his own control. As a result acquisition of declarative knowledge

leads to self-control over cognitive process. Kuhl and Fuhrman (1998:15) suggest that it is this mode of volition that supports maintenance of an active goal in mind.

In the knowledge compilation phase the learner integrates the sequences of cognitive and motor processes required to perform the task. The attentional load of a learner is reduced as task objectives and procedures are moved from working memory to long term-memory. Learning is less susceptible to interference from external attentional demands when a competing task is added.

2.6.2 Mathematics study skill acquisition and volition

Inadequate study skills are factors hindering learners' willingness to engage in mathematical learning activities Cangelosi, (1992:8). According to Kanfer and Ackerman (1989:661), procedural knowledge is the skill acquisition phase subsequent to knowledge compiling in which learners integrate the sequences of cognitive and motor processes required to in performing tasks. Bottge (2000) asserts that procedural knowledge involves step-by-step procedures that, when followed in a sequence, lead to correct answers.

In procedural knowledge learners acquire knowledge about how to perform various cognitive activities. The learner automates the skill and tasks can often be performed with little attention. After a substantial amount of consistent practice, skilled performance becomes fast, accurate, and the task can often be performed with minimal impairment while attention is diverted to a secondary task. Volitional strategies that enforce consistent task practice should lead to improve procedural knowledge.

Acting on one's volition, Corno (1993:14) postulates, is to use one's own resources and to sustain effort independent of external pressure. During persistent execution of procedural skill the attention effort load is reduced in the mind because task objectives and procedures are moved from working memory to long term memory. Reduction of attention load has some refreshing effect and stress release. Volition is regarded as a purposeful application of effort to sustain performance reducing stress and reinforcing self-confidence. It can be applied when

mathematics goals involve acquisition of complex or novel skills as attainment requires sustained attentional effort in pursuit of unexplored skills. It is when effort is to be sustained for an unknown period that one needs to have efficacy belief in one's effort. The self-efficacy beliefs, according to Ames (1992:268), mediate engagement patterns. In problem solving when learners outline: a plan, and self-regulatory processes of self-monitoring, self-evaluation and self-reactions effort can be sustained for an extended period. Hence planning and self-regulatory processes are volitional resources essential to skill acquisition. Empowerment with regard to planning and self-regulation as volitional strategies should lead to mathematics knowledge and skill acquisition.

Self-control that pertains to high action identity in mathematics contributes to reinforcing persistence. The influence of persistence in governing attitudinal change can be considered the appropriate medium for skill enforcement that in turn should influence achievements. Persistence during mathematics practising and training focuses attentional effort and may reinforce skill acquisition. Persistence is directly correlated to achievement (Miranda, 1998). Persistence leads to competency or character development, thus as a volitional resource it contributing to an individual's measurable potential for responsibility, dependability, or conscientiousness predictive of success in educational settings (Corno, 1993:15). When learners persist in appropriate engagement processes they acquire learning skills. If the execution of skills develops voluntarily learners tend to become more responsible in their learning of mathematics.

In this section literature study suggested that during mathematics knowledge compiling learners deploy their volition to decide to focus attention effort as they stay cognitively engaged. In focusing attention effort, volition supports the maintenance of the mathematical learning goal as learners integrate sequences of cognitive and motor processes required to perform the task. During procedural skill acquisition, volitional strategies enforce consistent task practice. It has been indicated that planning and self-regulatory processes of self-monitoring, self-evaluation and self-reactions which are necessary during problem solving are volitional strategies essential during mathematics skill acquisition. Persistence and aspects of

volition, during mathematics practising and training, on the other hand, focus attention and also reinforce skill acquisition.

2.7 SUMMARY ON THE CHAPTER

In this chapter, section 2.2, it is discussed how teacher conceptions influence mathematics teaching and learning. The instrumentalist teacher views mathematics as a bag of tools made up of accumulated facts, rules and skills that can only be used by a trained person. Their teaching is content focused with emphasis on performance and mastery of mathematical rules and procedures. The dynamic problem solver views mathematics knowledge as the generating of patterns which are assimilated into acquired knowledge. This is influenced by the social context, therefore affective factors embedded in the context like emotions, confidence, frustration and pride interact in a dynamic way with cognition to influence mathematics learning.

In section 2.3 study orientation was discussed with references to the six fields which entail (i) study attitudes, (ii) mathematics anxiety, (iii) study habits, (iv) problem-solving behaviour, (v) study milieu and (vi) information processing.

In section 2.4 the role of values in modifying the way of perceiving as they guide a learner's choice of action as well as degree of engagement and responsibility by the learner was discussed. The way beliefs control development of affective responses to mathematics situations such as trust and self-confidence was examined. It is acknowledged that belief in efficacy of one's effort mediates the approach to mathematics learning and that beliefs are related to notions of meta-cognition and self-regulation.

In section 2.5 the construct volition and its implications to mathematics learning were examined. Volition has been defined as thought processes that are directed towards maintaining one's attention to goal attainment even in the face of internal and external distractions. Volition is suggested in amplifying effects of motivation, thus promoting affect and the use of learning strategies as well as self-confidence towards skill deployment. It is

even hinted that emotional orientation affects the way mathematics activity is observed during conjecturing. Emotions are seen to inhibit risk-taking attitude and to interfere with learner motivation and to delay learner cognitive functioning. It is indicated that the dominant negative emotions signal the need for volition deployment. Volition is seen to indicate capacity for self-regulation in maintaining one's actions in line with one's integrated self.

In section 2.6 volition control was related to use of cognitive strategies for learning as it helps to maintain goal directed activity. The extended role of volition in encompassing the plans to sustain motivation and implement goals and strategic regulation of cognition was hinted at. Goal implementation strategies during mathematics problem solving lead to planning, monitoring and evaluation. A mathematics learner who employs volition control should take more responsibility in managing his or her own learning.

Furthermore it is alluded that volition has the role of focusing attention effort so that mathematics learners stay cognitively engaged, thus contributing to mathematics knowledge construction. In addition, by reinforcing consistent task practice, volition consolidates procedural knowledge during mathematics skill acquisition.

This chapter established that different mathematics viewpoints influence mathematics teaching and learning. Study orientation in mathematics affects the way learners are oriented towards learning and influences mathematics performance. Volition has some significant role to play during mathematics knowledge compilation and procedural knowledge and skill acquisition and therefore should influence performance. In chapter 3 we will discriminate between volitional strategies and learning context that promote mathematics learning. The influence of volitional strategies must be evaluated against study orientation and performance. The influence of learning context will be evaluated against the volitional strategies used by those learners.

CHAPTER 3

MATHEMATICS LEARNERS' VOLITIONAL STRATEGIES, LEARNING CONTEXT AND LEARNER PERFORMANCE

3.1 INTRODUCTION

In chapter 2 mathematics learning was indicated to be influenced by conceptions and beliefs about what mathematics is as held by teachers. The following are views about mathematics:

The instrumentalists view mathematics as fixed, made up of strict rules and procedures to be carried out in a specified manner only by trained persons. Their approach to mathematics teaching is content-based and emphasises mastery of mathematics rules and procedures and performance.

The dynamic problem solving view considers mathematics to be an expanding field of human creation in which patterns are generated and distilled into knowledge. According to this view, knowing entails adding to existing knowledge and understanding is a pre-requisite. In addition, mathematics can be discovered and mathematics learning is a process influenced by social context in which are embedded affective factors.

It was implied in chapter 2 that values and beliefs are embedded within the discipline of mathematics learning and that they determine study orientation.

In paragraph 2.3.1 study orientation in mathematics has been divided in terms of six fields as influenced by:

- (i) Study attitudes
- (ii) Mathematics anxiety

- (iii) Study habits
- (iv) Problem-solving
- (v) Study milieu (social, physical and experienced milieu)
- (vi) Information-processing.

Furthermore it was hinted at that volition is a variable believed to interact with affect, emotion, self-regulation and cognition during mathematics learning.

In chapter 3 an extensive study is made of volitional strategies in order to determine their influence on mathematics learning and performance. Secondly, an extensive review on social context within which effective learning occurs, is made. The influence of learning context on volitional strategies as used by the mathematics learner is interpreted with reference to learner performance.

3.2 DEFINITION OF VOLITIONAL STRATEGIES

Volitional strategies are defined as mediating processes proposed to promote the implementation and completion of intentions (Garcia *et al.*, 1998:399). In this particular research work, volitional strategy indicates an individuals' expressed choice of will to manage a cognitive task for the purpose of goal attainment, for example the learners' self- expressed choice to complete mathematics homework before going to play with friends. Thus volitional strategies are control processes involved in making sure that a goal (mathematics objective) is pursued or accomplished (Oettingen, H6Ning & Gallwitzer, 2000).

3.3 OVERVIEW OF THE ROLE OF VOLITIONAL STRATEGIES DURING MATHEMATICS ACTIVITIES IN SUSTAINING EFFORT

Mathematics activities include systematic exploration, acquiring and mastering of discovered concepts, relationships and conjectures. These processes are to be sustained

until meaning and understanding is developed within each individual. In this section, attention will be given to the role volitional strategy plays during mathematics activities in sustaining effort so that concepts or relationships can be discovered. The analogy where a tripod stand and vehicle mass were compared to volitional effort means that sustained maintenance of cognitive actions was made in earlier chapter (see page 43 section 2.6.2) where such comparison occurs. An expansion of the analogy is here made in which a vehicle without wheels is placed on a mobile trailer, which is being towed by another vehicle. Volitional strategies are compared to the effort applied by the locomotive mobile trailer that is being towed on which a non-mobile vehicle is placed. Mathematics learning occurs as the vehicle on the trailer is conveyed from point A to point B. The sustained effort in using volitional strategies when learners explore and conjecture leads to the establishment of cognitive actions that bring about mathematics learning.

It is essential for learners to implement volitional strategies in order to avert failure. This is in view of the fact that a child may fail mathematics at school despite having sufficient intellectual abilities if he or she has not developed appropriate volitional mechanisms and strategies, or if available competence cannot be accessed under conditions of stress or frustration. This assertion as made by Kuhl and Fuhrman (1998:43) is consistent with the upheld view that has prompted this investigative research work.

Earlier literature documented by Kuhl in 1985 and 2000 indicates that action-control beliefs are associated with mode of volition that supports the maintenance of an active goal. Lopez and Little (1996:300) concur and highlight coping strategies serve as potential mediators of the relations between psychological control and emotional adjustment. Lopez and Little (1996:301) even add that these coping strategies tap into the dimensions of activity as they are coupled with action-control beliefs in regulating children's emotional adjustment. The following are respectively sited as examples of action-control beliefs and coping strategies:

“ I am able to put effort on it ”

- “ I know what it takes ”
- “ I talk to others about how I feel ”
- “ I seek comfort in others ”.

In this regard emotions are included in interpreting maintenance of a mathematical activity.

Internal speech, which is an example of self-talk identified as a volitional strategy, conforms to a model of effective problem-solving that integrates ideas early, Dewey (1933) and Polya (1945) attest. Self-talk, also referred to as self-verbalisation, can occasion learner-outlining reasons for performing the task, thus intensifying self-motivation.

Self-consequating refers to learners' use of self-provided reinforcement as in self-reward for attainment of a specified goal or inflicting self-punishment for under-achievement towards completion of some mathematics task. This volitional strategy of self-consequating was found by Zimmerman and Martinez-Pons (1990) to be positively related to teacher ratings of students' self-regulation in the classroom.. Kuhl and Fuhrmann (1998) indicate that self-regulation supports the task of maintaining one's action in line with one's integrated self.

Literature as documented by Corno (1993), and McCann and Garcia (2000:260) suggests that the mobilisation and maintenance of one's attention and effort toward goal attainment are necessary pre-requisites to positive learning outcomes. Attention control and effort maintenance are needed especially when goal attainment requires extended concentration, and effort is applied over lengthy periods of time as in having to accomplish work on assigned mathematics projects. Thus volitional strategies would include means by which an individual learner will manage different aspects of how, when and where the project task is to be completed. The learner has to be involved in planning and means of monitoring. According to Kuhl and Fuhrman (1998), subjects who operate in the self-regulatory mode while pursuing their goals moderately use conscious

monitoring of their intentions. That is, they plan specific actions and initiate the planned behaviour at the right times and in suitable situations. These individuals, as Kuhl and Fuhrman (1998) posits, inherently control their attention and inhibit disturbing impulses like noise that distracts them from the task in order to stay with a difficult or unfamiliar task. Therefore, planning towards goal attainment, initiation of planned behaviour and monitoring demand volitional effort to sustain learner concentration.

In sum, volitional strategies can be implemented under stress or frustration to avert failure. Coping strategies are coupled with volitional strategies to regulate learner emotional adjustment. Mobilisation and maintenance of one's attention and effort towards goal attainment are necessary prerequisites to positive learning outcomes. There is a need for learners to link effort and strategy use through selective training. Other examples of volitional strategies necessary during mathematics learning include self-talk, self-consequating, self-regulation, attention control, planning and self-monitoring.

3.4 MATHEMATICS VOLITIONAL STRATEGIES

Literature, as documented by Teo and Quah (1999), indicates that volition entails the reception of information relating all past experiences to the present and then consciously making a choice or decision after which a move is made to carry out the decision. The course of action commences with a person's desires. This is followed by the phenomenon of choosing an action goal, initiating the appropriate actions and it terminates with the evaluation of the achieved action outcomes (Gollwitzer, 1990:64).

Kuhl and Fuhrmann (1998:23-24) produce an extensive list with components of volitional inventory that includes volitional strategies, volitional inhibitions and items of spontaneous control. The 12 volitional strategies listed in the volitional component inventory are implicated during self-control and self-regulation and therefore are responsible for goal maintenance and self-maintenance. In accordance with the purpose of the study, that upholds the view of volition in maintaining goal directed behaviour an elaborate overview will be made of the 12 volitional strategies. However, from the

component of volitional inventory a list of 6 volitional inhibition symptoms is given. These are invoked under frustrating or stressful conditions and when there is some decrease in the functional efficiency of specific volitional sub-components in demanding situations. The frustration contingent inhibition of enacting volitionally intended behaviour, that is hesitation or passive goal awareness as seen with energy deficit, implicit rejection and alienation is included. The punishment-contingent inhibitions of a feeling and of self-disengagement are classified into emotional perseverance, rigidity and over-control.

Furthermore, components of volitional inventory include symptoms of spontaneous control. Subjects in this non-volitional mode prefer to act spontaneously without planning.

Volitional strategies are illustrated through examples that are applicable during mathematics learning. According to Kuhl and Fuhrman (1998:23), the three main categories that support self-maintenance and goal maintenance are:

- 1 Self- regulation volitional strategies
- 2 Self- control volitional strategies
- 3 Self- reflection volitional strategies

There are six identified self-regulation volitional strategies namely attention control, motivation control, emotion control, arousal control, self-determination and decision control (see paragraph 3.4.1).

The five self-control volitional strategies are intention control, planning, initiating impulse control and failure control (see paragraph 3.4.2).

Self-reflection volitional strategy is known as volitional self-confidence (see paragraph 3.4.3).

The two main categories of volitional inhibition invoked under frustrating or stressful conditions detailed in paragraph 3.4.4 are:

- 4 Frustration-contingent inhibition of behaviour, and
- 5 Punishment-contingent inhibition of feeling and self-disengagement.

Frustration – contingent inhibition of behaviour enactment includes energy deficit, implicit rejection, and alienation.

Punishment-contingent inhibition of feeling and self-disengagement includes emotional perseverance, rigidity and over-control.

3.4.1 Self-regulation volitional strategies

3.4.1.1 *Attention control by mathematics learners and teachers*

Attention control refers to an individual's tendency to manipulate mindset and direct concentration towards specific aspects during mathematics learning. According to Naglieri and Gotting (1997:514), attentional processes provide an appropriate level of arousal, directive and selective attention that involve selective recognition of a particular stimulus and inhibition of responses to irrelevant stimuli. For example in algebra:

In trying to consciously keep attention to understanding the role of a constant 'c' in the straight-line graph relation

$$y = mx + c$$

In this cognitive activity the mindset is directed to the observed consistency between the numerical value 'c' and 'y-axis intercept' number in order to establish the relation between the two and thus conclude about the role of 'c' as y-intercept. The educator may assist the

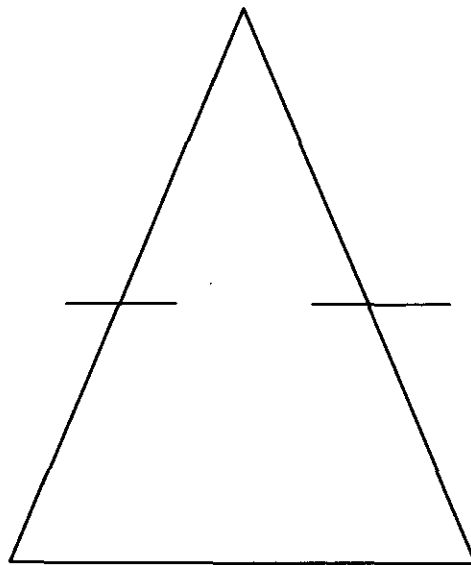
learner to focus attention by substituting varying values of 'c' while inhibiting the influence of slope 'm' by keeping the variable 'm' constant.

Or

in geometry

Try to pay attention to given information (see figure 3.1), such as length of line segment before identifying other properties such as angles, which are of same size.

Figure 3.1 –Isosceles triangle with equal sides and angles marked



3.4.1.2 Motivation control and ways of supporting implementation during mathematics learning

The need to regulate motivation is of academic importance. Research work by Wolters (1999) indicates that motivational control strategies can be used to predict learner use of learning strategies, effort and classroom performance. Wolters (1999:281) further suggests that learners who self-regulate their motivation should remain engaged in and successfully complete academic tasks more consistently than students who do not regulate their level of achievement motivation. Henningsen and Stein (1997:545) claim that teachers must know their students well in order to make intelligent choices regarding the motivational appeal needed to move students into the right cognitive and affective space so that high level thinking can occur and progress be made on mathematics tasks.

Bottge (2001:108) describes lack of motivation as one of defining characteristics of learners with learning disabilities that is contributed to by misunderstanding. According to Garcia et al. (1998:393) the influence of motivational processes on cognitive engagement is enhanced when volitional strategies are employed.

Motivation regulation involves various actions or tactics learners employ to maintain or increase their effort or persistence. This may involve learners intentionally extending time working at mathematics activities. Following are the five ways suggested as control ways in increasing motivation as well as illustrative mathematical examples.

- (1) Learners may increase their extrinsic reasons for completing the mathematics task by providing themselves with additional rewards or punishment based on some self-identified goals. Ames (1992:265) postulates that rewards can sometimes increase task persistence on ego evolving tasks by shifting the focus away from one's ability. Schunk (2000:354) concurs that rewards contingents on one's level of

performance are informative of capabilities and foster learners' self-efficacy, interest, and skill acquisition.

Examples: "If I complete my mathematics homework I will go and play with friends" or

"If I have successfully committed to memory the definition of a rectangle I will watch television".

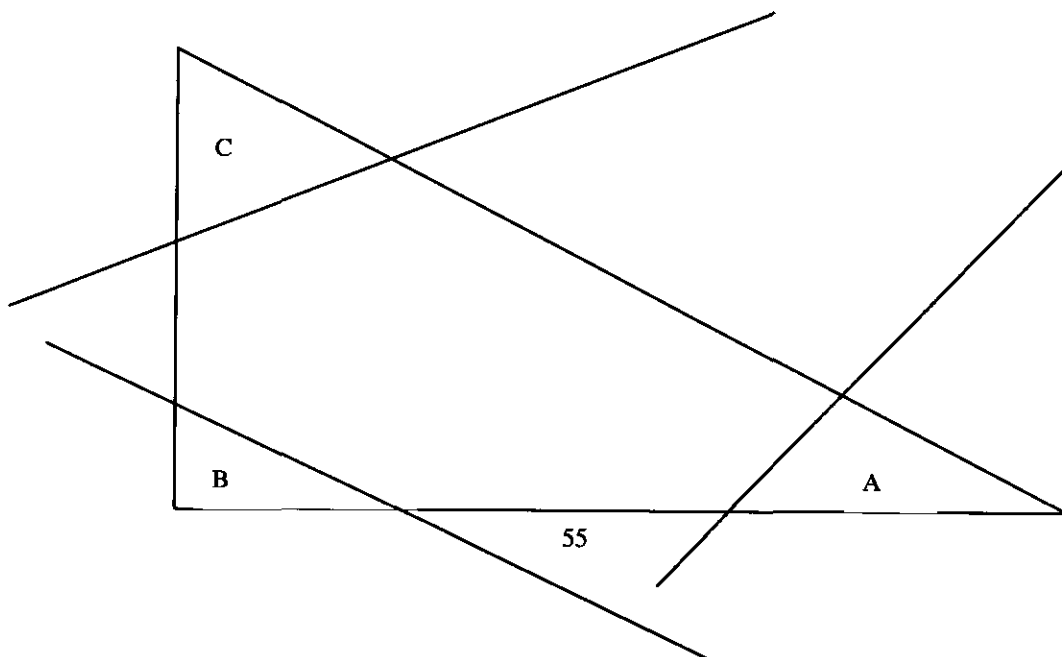
Teachers may as well contribute in increasing learner motivation by providing learners with rewards after achieving good performance on task.

- (2) Learners and teachers may increase the situational interest of the mathematics task by making it more enjoyable in order to increase learner's intrinsic motivation.

Example:. In geometry, cutting or folding actual and drawn shapes to check the correctness of a theorem can stimulate interest as in the following theorem (in figure 3.2 lines across indicate cut lines)

"Sum of interior angles in a triangle adds to 180° "

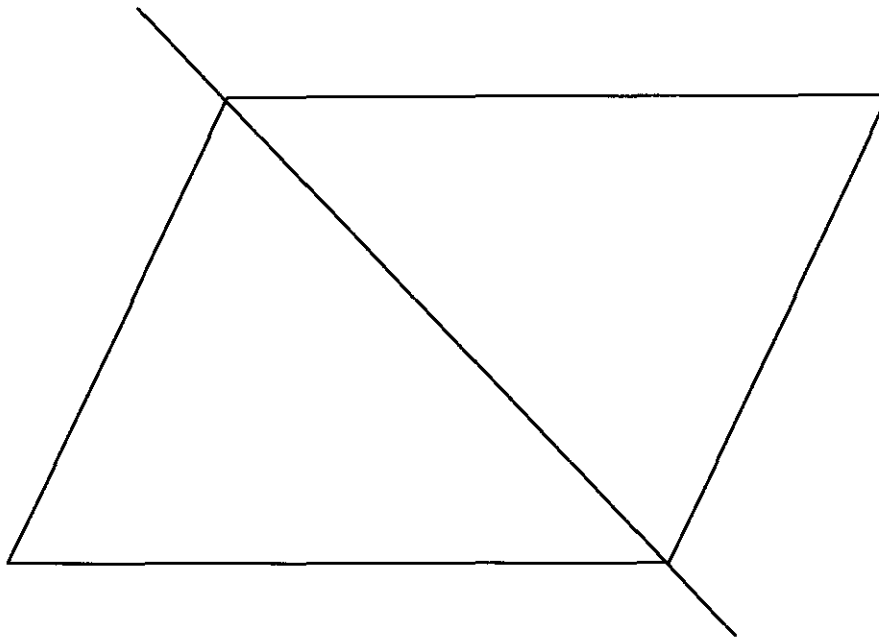
Figure 3.2 – Triangle with cut lines to detach angles



“The interior opposite angles of angles in a parallelogram are equal”

- The extended diagonal line through figure 3.3 indicates the fold line

Figure 3.3 – Parallelogram with fold line indicated



- (3) Learners may increase motivation regulation by articulating some already identified reasons for completing the task. Students who view mathematics favourably are more likely to persist in mathematics (Gross, 1988; Gwiddala & Steinback, 1990; Matthews, 1984; NCES, 1991).
Example: “I need to practice and try to understand more mathematics exercises so that I get good grades and do well on the coming test”.
- (4) Reminding self of desire to learn as much as possible can increase one’s motivation. Mastery related self-talk is associated with greater use of

strategies of elaboration, critical thinking and meta-cognition (Wolters, 1999:285).

Example: “ I need to master and learn more about mathematics since it is a compulsory pre-requisite subject for courses I intend pursuing at tertiary level”.

- (5) Motivation can be enhanced by environmental control. This involves effort to arrange surroundings so as to make completing a mathematics task easier or more likely to occur without interruption. Research work by Zimmerman and Martinez-Pons (1986, 1990) and Wolters (1999) indicates that learners report using environment control as means of increasing the likelihood of finishing homework (assignment) when other more appealing activities are available. The example is switching off or lowering the volume of sound of the radio or television while solving mathematics problems, or moving away from a noisy and destructive environment to a more quite place.
- (6) Motivation increases by manipulating aspects of one’s own physical or mental readiness, e.g. taking some deep breaths or exercising prior to starting some extensive study schedule.

3.4.1.3 Emotion control and ways of supporting implementation during mathematics activities

Dembo and Eaton (2000:475) suggest self-verbalisation, cognitive self-instruction or self-talk as important strategies for self-control. This is an assertion made in view of the fact that it is self-talk which influences thinking and emotions and thus ultimately guides behaviour. Emotional sentiments that influence volition are listed as anticipation, pride, hopelessness, disappointment, enjoyment and boredom. Emotion control thus refers to an individual’s self-expression to cheer himself up to make things work in mathematics even under any of the above mentioned states.

3.4.1.3.1

Learner hopelessness, disappointment and self-talk

Learners who are deficient of some volitional strategies find it difficult to overcome the emotional state of hopelessness and to maintain their efforts in studying mathematics. Persistent low marks obtained during test taking in mathematics may lead to some learners' disappointment and hopelessness. O'Conner and Miranda (2002:76) indicate that successful learners work hard to maintain high standards and to accept responsibility for their success and failure. Learners may be assisted to regain confidence and reassurance by using self-talk which is diagnostic as illustrated below. Cangelosi (1996:167) asserts that divergent thinking in thinking aloud sessions fosters creativity. For example, a learner may introspectively direct his own course of cognitive action as indicated:

"I need to spend more time on improving my memory retention ability in order to perform better on the next mathematics test."

"I must improve on my ability to recall the formulas and theorems accurately, thus I will spend more time on them after school."

The above statements even implicate a learner towards associating the self in maintaining a high action identity as Dewitte and Lens, (1999:325) suggest.

Self-talk should even remind a learner of the reasons for studying, for example

" When engaged in attractive activities I remind myself of my mathematics study schedule and I stop playing."

3.4.1.3.2

Pride, disappointment and self-talk

Learners, on the one hand, may be willing to go an extra-mile on mathematics learning by being co-operative and involved. When pride from successfully completing tasks becomes a reward, Schunk (2000:352) asserts that learners are intrinsically motivated to continue to display the new behaviour. On the other hand, learners may be unwilling to

participate in class for fear of being laughed at and ridiculed by others. Dornbusch (1996) indicates that successful learners work hard to maintain high standards and worry about the consequences of poor performance. These types of learners engage themselves more in introspective talk that reminds them of the importance to be committed to their learning activities. Egocentric speech is viewed as an important transition to learners development of private self-directive thought (Zimmerman and Risemberg, 1997:117). The self-talk associated with ego protection includes statements like:

“ I need to do well in mathematics so as not to disappoint my friends / parents, therefore I will try harder to stick to my mathematics study schedule and even seek help from the teacher ”.

3.4.1.4 Arousal control during mathematics test-taking

Arousal refers to incidences that occur to the learner unintentionally. Kushnir (1981:188) asserts that arousal level is a state imposed on the learner by the situational demands and by past experiences that drives performance. Arousal control entails a self-imposed internal state controlled by active plans and intentions (Kushnir, 1981:189). Furthermore, arousal control involves being able to calm down during anxious moments but invest effort voluntarily on task performance.

During mathematics test-taking anticipation of failure may create anxiety that interferes with cognitive activities like memory recall. A learner may waste time not arriving at a decision or being undecided which problem to tackle first. The volitional strategy of arousal control assists the learner to calm down during such anxious moments. These include relaxation techniques such as focussing on one's breathing to calm down prior to executing plans and intentions. Barlow (1992) even identifies both deep-relaxation training and visualisation relaxation as strategies reducing anxiety in procrastinators.

3.4.1.5 Self-determination by mathematics learners

Peer pressure influences decisions learners make during mathematics learning. Some learners may be more attracted to off-task activities during mathematics classes simply to act in harmony with peers. These activities may be actions like passing spontaneous and disruptive remarks during explanations made in class to divert the concentration of listeners. Other activities may involve non-contribution to class discussion.

During self-determination, Agran *et al.* (2002:283) purport, learners are engaged in self-regulated learning and act as the causal agent for choices, decisions and actions. Learners with self-determination are inclined to act in accordance with stipulated procedures and sustain concentration wilfully in or out of the classroom. They are at ease with their own decisions and do not yield to the ridiculing influence of others. Self-determined learners during instruction set goals, take action, and adjust goals. They are therefore persistently involved in all aspects of self-directed change during problem solving (Agran *et al.*, 2002:286).

3.4.1.6 Mathematics learner decision control

Learners who are purposeful and resolute stick to their guns, that is they remain in pursuit of their mathematics learning objectives. They optimise time and even practice mathematics at any available opportunity. They do not feel obliged to meet the expectations of others and are not affected by spontaneous decisions. Schunk (2000:409) postulates that time actually spent learning is influenced by the time learner is willing to spend learning. Teo and Quah (1999:26) assert that volition entails the conscious making of a choice or decision after which a move is made to carry out the decision on receipt of information relating past experiences to the present. Resolute learners persist at a task for the amount of time they require to learn and state their intentions fearlessly. The answer “no” or “not” can be categorically stated as in the following examples:

“ I will not be able to visit with you. I have mathematics on my study schedule which I am more obliged to adhere to.”

“ I am not going out on the sport trip, I have to catch up on my mathematics test preparation. ”

3.4.2 Self-control volitional strategies

3.4.2.1 Mathematics learner intention control /monitoring

When learners are assigned work on new topics in which they lack perspective, they are likely to lay off the work or postpone it. The work may be laid off until the last minute before time of submission when then the work is done hurriedly, with some details overlooked and left out. The procrastinating tendency can be remedied through intention control and monitoring that lead to action initiation, as maintained by Dewitte and Lens (1999:327). Intention means having a goal in mind and being self-consciously directed towards it (Hinton, 2001:106). Intention control is a volitional strategy that spells out the links between situational cues and goal directed behaviour. Hence Kuhl (2000:674) proposes that it can even lead one to implementation of unpleasant goals. Oettingen *et al.* (2000:705) concur that it enhances goal striving. In addition, intention control involves the learner rehearsing his own decisions as indicated in these examples:

“If I don’t obtain the unknown value to the geometry problem using analytical means, I will try another method in Euclidean geometry.”

“If I am asked by a friend to talk with instead of starting my mathematics homework, I will refer them to my study schedule to which I am more bound.”

In other words, the learner spells out the anticipated reaction that will help confront antagonistic and impeding behavioural action. According to Dewitte and Lens (1999), the spelling out of an “if” and “then” as well the associated commitment to perform goal directed behaviour once the critical situation is encountered, seem to facilitate timely action initiation. According to Oettingen et al (2000:705) adolescents who had to furnish

a set educational goal with relevant implementation intentions (specifying where, when and how they would start goal pursuit) were comparatively more successful in meeting the goal that is if – then plans).

3.4.2.2 Planning during mathematics learning

According to Naglier and Gottling (1997:513) contributory factors influencing performance in mathematics include lack of test preparation, inadequate revision and failure to study mathematics. Often learners do not exploit their own resourcefulness timely and consequently time catches up with them. They work through mathematics problems hurriedly or in some cases copy from others without having gained understanding. Planning processes provide for the programming, regulation and verification of behaviour and are responsible for behaviour such as asking questions, problem solving, and self-monitoring, Naglieri and Gottling (1997) suggests. Kushnir (1981:189) proposes that self-imposed internal state controlled by active plans and intentions influences behaviour in experimental situations. Planning is a cue to time management helping out the learner in thinking out the details of the requirements necessary in order that mathematics activity may take place as in:

Scheduling study hours with classmates to avoid procrastination and thus even opening possibilities of more resources one can tap into for support.

Assisting in managing different aspects of how, when and where mathematics activity is to be completed. This implies strategy formulation.

Planning is also of importance by assisting the learner in the following ways:

Interrupting ongoing unproductive behaviour such as talking with friends, watching television movies till late at night thus interfering with learner rest time.

Helping the learner divide time rationally throughout all syllabus content involving numerical literacy.

3.4.2.3 Initiating mathematics activities

The crucial step subsequent to planning is action initiation. Stables, Morgan and Jones (1999:450) proposes that learning must engage an individual in undertaking real tasks involving the exercise of personal initiative within the context of the culture that exists beyond as well as in the school. The impetus behind initiating simply entails getting started on the mathematics activity at the right time and in suitable situations. The learner's self-talk behind the action this time propels him in the following ways:

- 1 Get down to tackling the problem
- 2 Just do it now
- 3 Just read through the problem now
- 4 Just write down your response now.

3.4.2.4 Learner impulse control

Keller (1992:216) states, with reference to cognitive behavioural approach, that impulsive learners have not learned techniques for self-control as other learners have. They respond automatically in certain situations without considering alternative consequences of their behaviour. When learners are feeling vulnerable in view of some prevailing temptation, impulse control is needed. For example, impelling forces may be instant play or being talkative and negligent to concentrate on mathematics work at hand. Other impulsive and problematic behavioural actions encompass learner difficulty in organising work, difficulty in taking turns, frequently changing from one activity to another, and disregard for the rights of others. Problematic impulsive thinking ways Keller (1992) designates as jumping to conclusions, the inability to generate alternatives, not considering consequences of one's behaviour and not evaluating one's behaviour.

Such persistent impulsive actions can be remedied by deploying volitional means of impulse control through imposing self-discipline that is enforced by drawing one's attention to class rules. If a learner draws on his own thinking and imagines how awful another failure will be, he or she must escape and divert concentration to the mathematical aspect of activity. Remedy can as well be sought through self-instruction training that involves self-talk. Zimmerman and Risemberg (1997:118) assert that self-verbalising is of much value in focusing concentration.

3.4.2.5 *Learner failure control*

Instead of ruminating on test failure, a learner may use the test as yardstick and try to learn from mistakes. This can be achieved through purposeful tackling of corrections, highlighting mathematical misconceptions, seeking explanation and concentrating on employing more learning strategies.

3.4.3 Volitional self-reflection

Self-awareness is a non-reactive, judgmental attention to inner states, which encompasses self-reflectiveness even in the midst of turbulent emotions, Goleman (1995:25) states. Self-reflection is based on the learner's optimism and pride. Moreover, as Oettingen *et al.* (2000:718) reiterate, when expectations of success are high, binding goal commitments leading to increased effort and high academic performance emerge. These expectations determine one's self-confidence and are referred to as learner's volition-centred self-efficacy beliefs. The volitional efficacy beliefs are based on optimistic confidence toward successful volition action. This is explained by the extent to which the ego reflects beliefs signalling capability to apply effort that will enable learners to use volitional strategies despite the presence of turbulent emotions. Volitional self-reflection indicates how the individual identifies with the ability to apply effort to succeed despite distractions. The following illustrations serve to demonstrate volitional self-reflection:

“I am made of the right stuff and if I stick onto my schedule and do mathematics problems I should do well.”

“I am capable of succeeding and if I concentrate on my retention ability and memory recall I will make it through.”

“I can make it I know if I control my emotions.”

“I am capable of doing well if I timely implement my intentions and monitor my progress.”

3.5 DIFFICULTIES IN THE LEARNER ASSOCIATED WITH IMPLEMENTING SOME VOLITIONAL STRATEGIES DURING MATHEMATICS LEARNING

Dewitte and Lens (1999:326) caution that volition be used with measure and advance the following reasons:

- (1) Learners who are naturally highly motivated, skilled or with strong study habits may not need high levels of volition.
- (2) Some volitional strategies may work for some people but not for others, for example adaptive learners such as highly interested, gifted and emotionally stable learners may be less affected by volitional strategy use as it might divert attention away from the task and so weaken performance.
- (3) Drawing upon working memory to repeatedly remind oneself of the reasons why one is engaged in a certain task may interfere with efficient studying.
- (4) Self-talk is related to poorer performance in some types of tasks as in open questions, which require deep processing.
- (5) The use of high action identity only enhances performance on reproductive questions in procrastinators but decreases performance in creative questions.

Research results obtained by Teo and Quah (1999) concur. In an experimental educational intervention program designed on knowledge / volition and action it was found to be effective in augmenting the non-academic rather than the academic achievement of the experimental group.

In sum, volitional strategies that can be used in mathematics to promote self-regulation responsible for goal maintenance include attention control, motivation control, emotional control, arousal control, self-determination and decision control. The volitional strategies that promote self-control and self-maintenance include intention control, planning, initiating, impulse control and failure control. Volitional self-reflection entails beliefs about learners' own efficacy in the use of volitional strategies and this promotes self-confidence. It is therefore imperative to understand the role of volition in self-regulation. An assertion is made by Dewitte and Lens (1999) that volitional strategies should be applied with caution as they may work for some individuals but not for all.

3.6 LEARNING CONTEXT

3.6.1 Introduction

In this study learning context refers to the necessary circumstances in which mathematics learning is meant to occur. This includes the following aspects: social milieu, teacher, language of instruction as well as cultural aspects. In this regard mathematics context will be examined with reference to structure, social factors that hinder or support a student's mathematical thinking and reasoning, the teacher's role in hindering or supporting effective learning, volitional strategy use and language. An analogy of a ship's captain, seawater and prevailing wind in which the learner, like captain of the ship, has to steer his own learning course through decisive wilful actions is made between context and mathematics learner.

3.6.2 Mathematics learning context structure

Knowledge acquisition is dependent on the context in which the learning occurs.

Documented literature by Wolters and Pintrich (1998) indicates that motivational aspects of self-regulated learning are context specific and the level of cognitive strategy use is sensitive to contextual differences. Little *et al.* (1995) and Lopez (1999:313) are in agreement and add that cognitive, motivational, school specific and societal factors converge to provide the context in which children's perceptions of the causes of school performance are formed. Learners develop the understanding of mathematics through the social and cultural context of the classroom, Tamsin (2002:169) accedes. An enjoyable classroom environment mediates the relationship between a deep approach and high level achievement as observed by Wong and Watkins (1998:247). Thus a pleasant mood forms part of context structure during mathematics learning.

Dembo and Eaton (2000:475) testify that social, cultural and classroom interaction determines beliefs and perceptions of motivated behaviour. Thus in this regard the learner's belief system is central to the concept of context. According to Hinton (2001:106), belief is the background condition that indicates how the learner is situated in his or her environment and is therefore crucial in determining how an act is understood. At this point input by Lopez (1999:313) identifies the following factors, which he attests also to shape and regulate children's causal beliefs. These are namely (1) types of performance feedback, (2) teaching style, and (3) types of learning experiences. These tentative assumptions based on belief form the constructs of mathematics learning context.

Language is an indispensable core construct of the context as it is the means through which learners learn, then apply and are tested on mathematics concepts and skills. According to Sivan (1986), motivation depends on cognitive activity in interaction with socio-cultural and instructional factors, which include language and forms of assistance such as scaffolding of information.

The construction of the social context of the mathematics classroom is influenced by the cultural aspects such as expectations, intentions, system of roles and relationships, and generally the ways in which participants give significance to and make meaning of actions in social situations (Atweh *et al*, 1998).

Other attributes of context Norwich (1994:4) includes are competitiveness, negative feelings, cohesion and appropriate work that is doing and observing activities, imitation and repetition. Ames' (1992:263) list of context structures that lead to mastery goal orientation comprises of design of tasks, evaluation practices, use of rewards and distribution of authority or responsibility.

3.6.2.1 Study orientation and contextual factors that hinder / support learner's engagement and mathematical thinking and reasoning

Mathematics classrooms in which teaching supports learners' engagement, mathematical thinking and reasoning are said to be active. Kyriacou (1992:2) identifies giving pupils a marked degree of ownership and control over the learning activities as underlying active learning. Degree of ownership entails providing pupils with an opportunity in which they raise their own questions and use teachers and other resources to pursue self-determined goals. Learning environment in which learners are not ridiculed or laughed at by others when they make mistakes is conducive to improved ownership and learner control over activities. Learners are free to experiment, question, and hypothesise without being embarrassed. Inquiry based and social approach leads learners to be involved in questioning, inductive and analytical reasoning and speaking up in class (Tamsin, 2002:179). This should be a pleasant and supportive atmosphere in which students even influence procedures. Learners should be responsible for most of their own work but with some personal teacher involvement when learners are in need. Documented research by Lopez and Little (1996:309) indicates that:

Problem-solving skills, including children's use of others to help solve problems (pro-social coping) are integrally tied to their intellectual competencies, their ability to construe problems, the availability of social resources to assist in problems, and their social development.

Maree *et al.* (1997:8) likewise assert that learning strategy use prevails in a learning context that gives preference to a problem-centred solution approach and where there is co-operative attempting of mathematics problems.

Bottge (2001) indicates that during directive instruction the teacher's work that is well structured, specifying important tasks with carefully constructed explicit instructions can dramatically improve computational skills of learners with disabilities. Cangelosi (1996:167) points to direct instruction as a tool in leading learners to develop and polish memory level and algorithmic skills. Furthermore, he envisages that reception and retention could be facilitated through direct instruction in phases that include exposition, explication, mnemonics, monitoring and feedback, and over-learning.

3.6.2.2 The teacher's role in supporting conducive mathematics context

Tamsin (2002:176) suggests that learners who are field dependent have more difficulty organising the information that they are learning unless it is already structured for them. In addition, field dependent learners have difficulties identifying relevant information in word problems or when writing proofs, but they however learn more easily if the information is within social context with which they are familiar. In this regard close links between teacher and learners in class are necessary. Kuhl (2000:693) reiterates that the teacher who is consistently friendly and encouraging or who uses positive thinking or humour may provide a good basis for enhancing students' self-motivation. Therefore the teacher must structure information and be friendly to learners.

In addition, the teacher should keep tight reins in class, insist on negotiated class rules and procedures, correct student behaviour and be demanding. Teaching behaviour found

to support high-level student engagement involves consistently pressing students to provide meaningful explanations (Anderson, 1989; Doyle, 1988; Henningsen *et al.*, 1997). Hence teacher authority is necessary to regulate intrusive learner behaviour during explanations by others.

On one hand, Kuhl (2000:689) postulates that a teaching style leading to affective bias is a risk factor with regard to adaptive control behaviour. The effectiveness of learner motivation and self-regulation is influenced by teacher tendencies. Teachers who prefer processing information in wholes other than processing it in parts will influence the way learners are motivated towards processing it. Teachers who express more feelings over dreading or disliking mathematics likewise will influence learner motivation and self-regulation in liking the subject. In other words, an excessive bias towards negative affect, as Kuhl (2000) asserts, impairs self-management of attention, motivation and emotion. These affect how self-congruent and realistic goals are formed as intrinsic motivation is recruited for negative support while feedback is utilised in an adaptive way. In their teaching, an upbeat attitude is to be maintained as opposed to displaying an excessive negative affect, for example no hurting statements should be made about incorrect answers but instead positive remarks should be made on learner attempts and some awards should be given to learners for effort expended.

3.6.2.3 Context and volitional strategy use

3.6.2.3.1 Context and decision making

Hinton (2001:119) posits that behaviour can be described as an activity in which an organism interacts sometimes by responding, and sometimes by initiating behaviour within its environment. Learners achieve an objective within the willingness to try learning a level by choosing to attempt a mathematics task specified by the objective, Cangelosi, (1996) attests. Decisions learners make contribute to the form of context. As an example, a learner may be expected to list items common in a relation or write in an

orderly manner so that the work can be readily checked for errors. Within some co-operative context learners respond by either making an attempt or choosing to oblige with instructions.

3.6.2.3.2 Context and time management

Kanfer and Ackerman (1989:657) propose information processing and ability demands change as a function of practice, training paradigm and timing of a goal setting.

Classroom contexts discussed in terms of tasks, authority, recognition, grouping, evaluation, and time influence development of student mastery goal orientation, Dembo and Eaton (1996:8) reaffirm. It is thus suggested that goal orientation with time constraints influence student cognitive engagement and motivated behaviour. The element of time within the context is of the utmost importance. Learners write mathematics tests and examinations within the specified time duration.

There is a need to train learners in time management techniques as in creating daily and weekly time management schedules. Teachers are to assist in monitoring and the use of the time management plans.

3.6.2.3.3 Context effect on emotional control and confidence

McCann and Garcia (1999:3) postulate that emotions such as anticipation, hopelessness, enjoyment, boredom, pride and disappointment, are proposed to influence both motivational and volitional processes by inhibiting or promoting successful goal outcomes. Another emotional factor embedded in the learning context that inhibits successful goals is a non-stimulating environment. Moreover, Maree *et al.* (1997:9) ascribe non-stimulating learning and study environments and non-understanding of the specific language of mathematics to mathematics anxiety that undermines pupils' self-confidence and inhibits mathematics achievement. In addition, according to Lopez and Little (1996:300), anxiety poses a threat or challenges to learners' action control beliefs

engendering stress that in turn initiates coping response. These coping strategies that regulate learner affect together with orientation towards others are embedded in the social context. For example, pro-social coping strategies are means by which learners seek out and engage in the assistance of others. On the otherhand, antisocial coping strategies are means by which learners aggressively work against others. Direct and coping-action strategies also include seeking information, and seeking social emotional support while indirect non-coping action strategies include avoidance, changing one's problem perceptions and emotion management. Lopez and Little consider coping strategies as potential mediators of the relations between psychological control such as beliefs and emotional adjustment. The extent to which management of disruptive emotional states influences motivation and volitional processes by inhibiting goal outcomes during mathematics learning will be investigated, using the Academic Volitional Strategy Inventory (see appendix D) in the empirical survey.

3.6.2.3.4 Context effect on attention and motivation control

Research by Turner *et al.* (2003) reveals that features of the classroom context such as motivational support provided through instructional practices might be related to student outcomes in high performance classrooms as it is documented that:

Students in the classrooms in which there was constant and explicit support for autonomy and intrinsic motivation, positive affect and collaboration reported less negative affect and self-handicapping. Students in the classroom in which there was less supportive motivational discourse reported more negative affect and self-handicapping.

Stables (1999:459) accedes that a classroom culture in which discussion of mathematics is encouraged within a supportive atmosphere permits students to present their findings, and to explain their methods and results to others, for constructive comments from the teacher and from other students.

Consistent task practice is associated with higher levels of performance and decreasing demands on attention, Norman and Bobrow (1975) and Kanfer and Ackerman (1989:660) affirm. Notably, as well Miranda, (2002) also reiterates that achievement motivated behaviour is operationalised by risk-taking, persistence that entails a number of trials attempted on an unsolvable task and performance which includes speed and accuracy.

3.6.3 Contextual influence and performance

Ames (1992:265) proposes that the focus on social comparison standards interferes with effort-based strategies that require deeper levels of information processing. In evaluative settings where performance is the only success core criteria learners are emotionally taxed. Some learners, for fear of being embarrassed especially those who are egocentric, in avoiding failure resort to cheating, feinting or displaying performance avoidance behaviour. In his research of high school aboriginal learners, Tamsin (2002:175) found that during the course of the year at school there was a steady decline in preference for both competitive and individualistic learning situations and a steady increase in preference for co-operative learning in relation to competitive learning. Learner classroom competitive behaviour for the sake of competition not emphasising performance accuracy on completion of work and understanding is discouraged.

In accordance with documented research by Lopez, (1999:312), performance avoidance goal behaviour was positively related to test anxiety because the more one is motivated to avoid failure, the more anxious one becomes when tested.

There is a need for assessment procedures that help decide which student's performance may be optimised by direct instruction for example evaluation measures that take into account the level of interest or willingness to participate during mathematics activities. Outcome-based approaches that advocate diverse forms of assessment are commendable.

3.6.4 Language role-playing in mathematics context

Vygotsky's socio-cultural theory indicates that the social environment influences cognition through its cultural objects, language and social institutions. Language is one of the tools that people use to transform their behaviour as they develop new understandings about the context in which they work (Bottge, 2001). Learners explore concepts as they work and discuss problems. Cognitive change results from using cultural tools in social interactions and from internalising and transforming these interactions. In inductive lessons when learners assume the role of experimenters through making observations, describing results and discussing them with teachers, they increase their level of understanding.

Learning mathematics consists of developing progressive co-ordination between various registers (Duval, 2000:65). Cummins (1996) puts forward that children who learn through a second language would not achieve the same outcomes as those learning through their first language. As implied, learning academic registers such as that of mathematics takes a longer period. Mathematical activity in problem solving situations requires the ability to change register, either because another presentation of data fits better an already known model or because two registers must be brought into play, like figures and native language (Duval, 2000:63).

In substantiation, Berry (1985) in his discussion of the teaching of mathematics in Botswana emphasises the 'distance' between the language of the learner and the language of the curriculum developer. In looking at the problems Botswana children were having in learning school mathematics, Berry suggests that even where a mathematical register was engineered in the indigenous language, there could still be a clash between the different underlying cognitive structures of the mathematics register and the indigenous language. This could result in children failing to learn sufficient mathematics to enable them to use it to solve problems.

3.6.5 Summary and implications of context for mathematics learning

In this section it is indicated that mathematics understanding is developed through social and cultural classroom interaction. Belief systems are central to the concept of context as the casual beliefs are shaped by teaching style, language and performance feedback. Other structural components of context include expectations, intentions, roles and relationships. Learning experiences that constitute context involve competitiveness, dealing with negative feelings, design of tasks, evaluation practices, authority and responsibility. It is noted that problem solving that involves inquiry based approach to mathematics learning supports learner engagement, mathematical thinking and reasoning. In addition, the teacher's role during direct instruction is necessary to facilitate learner reception and retention of computational skills. Some mathematics learning context in which the teacher as authority in class regulates atmosphere to provide for learner explanations and does not display excessive affective bias is recommendable.

It is revealed that mathematics context should provide for learner decision-making, time restraint and be able to cater for learner emotional adjustments. Mathematics classroom instruction context must be able to support consistent task practice in a sustainable motivated environment. There is also some need for classroom based factors that reduce focus on social comparison but stress accuracy on performance and understanding. In addition, evaluation measures that are diversified with regard to content, interest, willingness to attempt and in line with an outcomes based approach are suggested. The section also implicated the influence of second language in which mathematics is taught as affecting mathematics register, understanding and ultimately performance.

3.7 CONCLUSION

In section 3.2 volitional strategies were defined as learner's expressed wilful choice advanced to manage some cognitive tasks for the purpose of implementation and completion of intentions.

In section 3.3 the need to engage attention on volition as pre-requisite to positive learning outcomes was made through establishing the following reasons:

The need for the implementation of volitional strategies under stress or frustration to avert failure and to make necessary emotional adjustments.

The need for mobilisation and maintenance of attention and effort towards goal attainment.

The need for linking effort and strategy use through selective training.

In section 3.4 volitional strategies that can be applied in mathematics learning were categorised into those that promote self-regulation and self-control. The self-regulatory strategies are responsible for goal maintenance, and namely attention control, motivation control, emotion control, arousal control, self-determination and decision control. The self-control strategies are responsible for self-maintenance and are intention control, planning, initiating, and impulse control and failure control. In addition, the volitional efficacy determining strategy of self-reflection was included.

In section 3.5 measures that caution against over-complacency on volitional use were advanced.

In section 3.6 some reviews indicating structural components of the mathematical learning context were made. It was noted that some social structure afforded learner decision making and emotional adjustment support study orientation and that these consequently affect learner engagement particularly mathematics thinking and reasoning. The role of the teacher as component of context in supporting conducive mathematics learning through imposition of direct instruction was made. The contextual influence on learner volitional strategy use was implicated in promoting learner decision-making, time management and emotional control. Some of the contextual factors reviewed like beliefs, expectations, intentions and problem solving influence learner attention and motivation

and consequently performance. Lastly, the role of second language in the context as medium of instruction for mathematics that interferes with cognitive registers was made.

In chapter 3 the need to tow an effort load (volition) in order to bring about motion of a stagnant vehicle (mathematical learning) is established through means of volitional strategies that promote self-regulation and self-control in goal maintenance and self-maintenance to bring about mathematics learning. The volitional strategies are identified and their influence on mathematics learning implicated. The structural components of the social context that influence mathematics learning are identified as well. In addition the influence of learning context on volitional strategies as used by mathematics learners was interpreted with reference to performance.

From the above summary research questions were posed in this study (see paragraph 1.2).

In chapter 4 the aims of an empirical investigation together with design and procedure used in the measurement of learner perceptions towards volitional strategy use and study orientation are outlined. The context is captured through lessons observed.

CHAPTER 4

RESEARCH DESIGN AND PROCEDURE

4.1 INTRODUCTION

In chapter 3 the volitional strategies that fundamentally determine learners' study orientation and influence mathematics learning were analysed. Secondly, skills and abilities in the context that influence learners' self-control and self-regulation leading to improved mathematics performance were examined. In this chapter the aims of the empirical study and some research questions are formulated based on the findings from reviewed literature. The research design and procedure used in the measurement of the perceptions of grade 10 learners towards the variables of the study to test research questions are described.

4.2 AIMS OF THE EMPIRICAL STUDY

There is a dire need to enhance and improve the quality of teaching and learning of mathematics in schools with regard to the fact that mathematics is identified in the National Curriculum Statement as being capable to enable learners to organise, interpret and manage authentic activities in substantial mathematical ways that demonstrate responsibility and sensitivity to personal and broader societal concerns (Dept. of Education, 2003: 50). Furthermore, it has been pointed out in paragraph 1.1 that one of the critical outcomes endorsed in the principles of the National Curriculum Statement includes learners being able to organise and manage themselves and their activities responsibly and effectively (Dept. of Education, 2003: 8). Since responsibility and personal concern are embedded in the self there is a necessity to include volition during mathematics teaching and learning. In paragraph 1.2 learner volition is identified as the key self-regulatory process that influences performance proficiency, particularly in mathematics.

With reference to the preceding statements, aims of the empirical research were to investigate the learning of mathematics as exhibited by learner performance in grade 10 classes, with particular attention to the use of volitional strategies, prevalent learning context and study orientation (see outline in paragraph 1.2).

The objectives of this study are summarised as outlined (see paragraph 1.3):

4.3 RESEARCH QUESTIONS

In the empirical study the following research questions were posed:

Research question 1

How does the use of volitional strategies and learners' study orientation influence mathematics performance in grade 10?

Research question 1.1

Are there any significant differences in the perceptions of sampled groups from the study population with regard to volitional strategy use in mathematics in grade 10 and study orientation?

Research question 1.2

Are there any significant differences in the perceptions of sampled groups from a study population with regard to study orientation in mathematics in grade 10 as determined by learner performance?

Research question 1.3

Are there any significant differences in the perceptions of sampled groups from the study population with regard to volitional strategy use in mathematics in grade 10 as determined by learner performance?

Research question 2

How does the learning context in grade 10 mathematics classes influence deployment of learner volitional strategies and ultimate learner performance?

Research question 2.1

Are there any significant differences from a study population with regard to prevalent context in mathematics in grade 10 and learner performance?

Research question 2.2

Are there any significant differences from the study population with regard to learner perceptions about study orientation and prevalent context in mathematics in grade 10?

Research question 2.3

Are there any significant differences in the perceptions of two sampled groups from the study population in different learning contexts with regard to volitional strategy use in mathematics in grade 10?

Research question 3

Within the theoretical premises and the empirical results of this study, what recommendations emanating from volitional strategy use are proposed?

4.4 RESEARCH METHODOLOGY

4.4.1 Design

The design of the study entails an *ex post facto* investigation that combines both quantitative and qualitative research means. These entail observing existing conditions and searching backward through the data for plausible causal factors. The effect of learner volitional strategy use and study orientation on mathematics as independent variables are investigated on mathematics performance taken as dependent variable in grade 10. The combined effect of volitional strategy use and study orientation is determined by observing the prevalent learning context in some schools with a past record of good performance and the others with past poor performance in matric results.

4.4.2 Population and sampling

A random stratified cluster sample of eight grade 10 classes was drawn as follows from schools in the Rustenburg district in the North West Province. The schools' results for the past three years were considered in each stratum. Stratum 1 was formed by two classes each from two schools with a matric pass rate better than 80 percent while stratum 2 was formed by two classes each from two schools with a matric pass rate less than 30 percent. The four teachers were included as well. The sample involved schools that are situated in urban and rural areas.

Table 4 - Stratification into matric pass rate > 80% and matric pass rate < 30%

STRATUM 1 - Matric Pass rate >80%			STRATUM 2 – Matric Pass rate <30%		
School	Number of candidates	Location	School	Number of candidates	Location
School R	79	Urban	School K	93	Rural
School S	106	Rural	School T	116	Rural
TOTAL	187			209	(396)

4.4.3 Measuring instruments

4.4.3.1 Academic tests

Two tests were administered to all participants, one in April and another in July. The purpose of the two tests was to determine the effect of teaching and context on volitional strategy use and study orientation that occurred at the same time interval in different schools. Both tests were aimed at assessing mathematics content knowledge, mathematics skills, comprehension of mathematics concepts, and problem solving ability. The April test (T₁) had a duration of 1½ hours, aimed at assessing knowledge of mathematics content covered as prescribed in the syllabus for grade 9 and part of grade 10 mathematics up to end of first school term. The test was marked out of 100 and contained multiple choice questions together with short structured questions where learners were expected to indicate their own work. The mathematics subject advisor moderated this test (see Appendix A). The July test (T₂) covered more of the work done in grade 10 in four schools up to mid-year. This test was set after consultation with the teachers concerned, based on the mathematics content as covered and as reflected even by what was set for June examination in each school. All the teachers responsible for the classes moderated the test. The test had a duration of an hour with few multiple-choice questions and short structured questions including word problem and it was marked out of 100 (see Appendix B). Both mathematics tests measured mathematics proficiency levels ranging from competence in simple arithmetic, using whole numbers proficiency in solving word problems and demonstrating knowledge of mathematics found in geometry shapes. These tests that involved cognitive ability and indicated mathematics learner achievement were marked and individual learner performance was recorded.

In addition, all participants responded to self-explanatory different survey questionnaires that were titled Study Orientation in Mathematics (SOM), Academic Volitional Strategy Inventory (AVSI) and Volitional Component Inventory (VCI).

4.4.3.2 Study orientation in mathematics questionnaire

The Human Science Research Council SOM questionnaire, as compiled by Mare (1996) was used. The SOM comprised 92-item, self-report Likert-scaled survey that was completed during two regularly scheduled class periods. Learners responded to the SOM questionnaire by marking on a separate answer sheet the responses that reflect their honest feelings about each statement. Marked answer was chosen from one of the five possible answers:

The following explanation of the symbols used was included:

1	:	Rarely	(0 to 15% of the time)
2	:	Sometimes	(16 to 35% of the time)
3	:	Frequently	(36 to 65% of the time)
4	:	Generally	(66 to 85% of the time)
5	:	Almost always	(86 to 100% of the time)

It was indicated that the learners should rate themselves as they are in the habit of doing or feeling.

In section 2.3 the six different fields of SOM that assess learners' study orientation were discussed. It contained some specific examples of items used in the named fields.

4.4.3.2.1 Study attitude

The field of study attitude comprises 14 questions and has a bearing on feelings that involve subjective experiences. Some examples of items involve question such as:

- 6. I believe I can do well in maths.
- 16. I think maths topics are useful.

Some items have a bearing on feelings that involve objective experiences and these involve questions like:

- 13. I postpone my maths homework and do something I enjoy more.
- 33. When I start doing maths I become sleepy, tired or bored.
- 38. After having worked for a while I find that I cannot concentrate on maths any more.
- 55. I continue working in maths, even if I find it uninteresting or boring.

Other items have a bearing on attitudes towards mathematics and aspects of mathematics that are manifested consistently and that affect learners' motivation and expectation with respect to, and interest in mathematics. Attitudes include factors, like enjoyment of the subject, self-confidence, usefulness of the subject and the challenges it offers. Item questions as included are:

- 21. It is more important to me to know how to solve a maths problem than just to find the answer.
- 48. I believe it is important to use maths to help to make the world a better place.

4.4.3.2.2 Mathematics anxiety

The field of mathematics anxiety comprises 14 questions wherein panic, anxiety and concern are manifested in the form of aimless repetitive behaviour such as in the following examples of item questions:

- 17. I lose marks in maths tests and exams because I cross out correct answers.
- 22. When my friends talk about a sum or way of solving a problem in the maths class I chew on my fingernails, pencil or other objects.
- 29. I play nervously with my pen, ruler or something else when I have to solve difficult maths problems.
- 49. in the math class, I find that I have to visit the toilet.
- 66. I move my feet when my math's teacher asks me a question.

Emotional liability

Maree *et al.* (1997:7) assert that pupils' motivation in mathematics is affected negatively when they are emotionally disturbed. Some items are aimed at determining emotional liability in mathematics class as indicated by these examples:

- 39. While writing maths tests or exams, I become worried when I see how quickly the other children work while I make slow progress because I battle.

- 61. I struggle with certain sums because I have not read them carefully.
- 34. I lose marks in maths tests and exams because I work too quickly or too slowly.
- 2. While answering tests or exams in maths, I panic.
- 12. I cannot speak clearly when I suddenly have to answer a question in maths class.
- 71. I am afraid to discuss my personal problems with my maths teacher.

4.4.3.2.3 Study habits

The field of study habits in mathematics comprises questions that display acquired consistent effective study methods and habits. Item illustration involves planning time and preparation as well as working through more than just familiar problems. As indicated by Maree *et al.* (1997:8), it includes a willingness to not only gain insight into certain aspects of mathematics, but also to learn theorems, rules and definitions properly and carrying out assignments in mathematics in a focused manner. Item illustrations are as follows:

- 72. I make sure that I know how much time I need for revision before maths tests and exams and I plan my time accordingly.
- 30. While doing my homework in maths, it is important to me to find out which concepts (ideas) I do not understand.
- 40. I make sure that I follow up my maths tests and exams and that I understand why I have made mistakes.
- 45. I learn formulas and theorems until I know them by heart.
- 62. When preparing for maths tests and exams, I work out a number of new problems and not only well-known problems.

Study habits entail indicating the extent to which learners promptly completes assignments and tasks in mathematics, keeping home-work up to date and avoiding wasting time. Examples are:

- 23. I keep my maths homework up-to-date by completing every day's work properly.

35. I postpone my maths homework (or to learn for a maths test) by doing something else first.

In addition, study habits include the willingness to do mathematics consistently in spite of the fact that other (to the learner), more attractive/ “nicer” activities could have been done instead. Thus it indicates how study attitude in mathematics is manifested in specific study habits in mathematics.

50. I make sure that my sketches in geometry are big and clear, I use colour pencils to make the sketches more clear to me.
60. I try to be interested in maths even if it seems more enjoyable to do something else.

4.4.3.2.4 Problem solving behaviour

Problem-solving behaviour in the mathematics field comprises questions that include more cognitive and meta-cognitive learning strategies. These include planning, self-monitoring, self-evaluation, self-regulation and decision making during problem solving in mathematics. And even as Polya suggested problem solving requires carrying out four steps of problem identification, formulation of the plan or strategy, implementation of the plan and verification of answer. Item questions include the following:

24. As far as I can, I look for a less difficult example of a maths problem to try to solve it (to see how work that I know well is connected to new work).
41. I first read through all the work quickly to get a complete picture of the test or exam work in maths on which I shall be tested before I begin preparing.
51. While doing a long sum, I stop in between to make sure I understand what I have already done.

Problem solving also includes other strategies like searching for patterns and relations in mathematics, the ongoing testing, estimating and approximating of answers.

46. When I find that I do not understand a sum, I look at it from another angle or read it in another way.

- 58. It is important to me to estimate my answers in maths before doing the actual calculations.
- 75. I try to find patterns when I do maths.

An assertion is made by Maree *et al.* (1997:8) that problem-centred solution approach and sociable co-operative attempting of mathematics problems enable flourishing of learning strategies. In the social environments where learners actively participate there is need for learners to acquire the language of mathematics, ways of expressing terms and explanations that are acceptable in classroom concerned. Thus problem solving embodies means to discuss, explain, and searching for possibilities of applying mathematics in real life. Item questions in this regard are illustrated as follows:

- 4. I explain maths to my friends, parents or other persons.
- 19. I try to find connections between different sections of maths.
- 36. I try to apply the maths that I learn in class in everyday life.
- 63. I talk to my friends about maths and we discuss mathematical terms and concepts.
- 68. I ask questions and take part in discussions during the maths lesson.

4.4.3.2.5 Study milieu

Study milieu encompasses social, physical and experienced milieu in mathematics. This field includes restrictive circumstances at home, frustration, and non-stimulating learning and study environments. Examples of item questions included are:

- 32. It is my parents or teacher's fault that I do not work hard at maths.
- 42. I get poor marks in maths because of the situation at home.

Milieu involves physical problems like the inability to see or hear well, reading problems, and names and life styles in word problems that do not come from the pupil's field of experience. The following item questions are included:

- 37. I cannot see or hear well in maths class, but I hesitate to mention it to my teacher.
- 69. I read slowly, therefore I do not complete my test and exam papers

59. The names and examples that are used in “word problems” are unfamiliar to me.

In addition, study milieu includes language problems including problems as posed by second language instruction. According to Maree *et al.* (1997:9), language background that is restrictive and milieu deprivation that are limiting, confuse learners and undermine performance in mathematics. Item questions as illustrated are as follows:

5. My teacher uses words that I do not know and that confuse me.
47. I do not understand words in maths.

4.4.3.2.6 Information processing

The last field included on SOM is of information processing. This field comprises questions that include general and specific learning, summarising and reading strategies, critical thinking and understanding strategies which involve the optimum use of sketches, tables and diagrams.

83. I make use of tables, sketches and diagrams to solve maths problems
77. I do badly in geometry because I make wrong assumptions; erroneously accepting, for example, that any point O within a circle must necessarily be the centre of the circle.
78. I find, especially in geometry, that I attribute properties to sketches while it does not have the properties.

Information processing in mathematics indicates the extent to which conceptualisation is complete. When conceptualisation in mathematics is incomplete, learners use inappropriate evidence and perform farfetched incorrect calculations, incorrect allocation of values to unknowns and the incorrect allocation of qualities. In such cases learners find it difficult to distinguish between what is “given” and what is “required” in mathematics questions. Item questions measuring this aspect of information processing include the following:

86. I give incorrect numerical values to unknowns.

- 89. I use formulas/ symbols incorrectly.
- 91. During maths exams and tests I ignore facts that are “given”, or I accept something as “given” when it is not the case.

On the other hand, when learners do not succeed in realising which concepts are related understanding and knowing do not work adequately, learners are negligent and will probably use theorems and formulas without thinking about their appropriateness. Examples of some item questions indicating this aspect of information processing are as follows:

- 81. My mark for geometry is lower than it should be because I cannot apply certain theorems during maths tests and exams.
- 84. I lose marks because I prove something that was not asked to prove in maths tests and exams.

4.4.3.3 Academic Volitional Strategy Inventory (AVSI)

Learners also responded to 30 items designed to assess their academic volitional strategy use. Items on this instrument were adapted from The Academic Volitional Strategy Inventory developed by McCann and Garcia (1999). The AVSI is a self-report instrument designed to assess the management of emotion and motivation by high school learners during the goal-striving process. The AVSI was developed to capture strategic methods used by learners to regulate their emotion and motivation if faced with distractions threatening ongoing activity. In earlier sections following paragraphs 2.5.3, 2.5.4, 2.5.5 and 3.4.1 of this construct, significant role of volition was implicated.

The adapted AVSI instrument as used in this empirical survey comprised a three-factor with item groupings consisting of strategies reflecting (1) self-efficacy enhancement, (2) stress reduction and (3)-negative based incentives.

Item questions measuring aspect (1) re-assuring thoughts that enhance self-efficacy include the following:

- 1 I remind myself that I usually do fine on mathematics exams, homework, classwork and projects when I stay on track with my studying.
- 6 I think about how relieved I'll feel when I get this mathematics problem finished.
- 13. I think about the goals I have set for myself and how I perform in mathematics may affect my future.

Item questions measuring aspect (2) stress-reducing or “calming” actions include:

- 15 When I can't get down to mathematics practising if I get frustrated or interrupted during studying, I count to 10 to help me get on track with it.
- 19. I call a friend from class and discuss the mathematics homework with him/her.
- 23. I schedule regular mathematics study hours with a friend from class so that I won't fall behind on my class homework and feel bad or guilty for putting off studying.

Item questions measuring aspect (3) thoughts about negative consequences of poor performance or negative based incentives include the following:

- 5. I think about the mistakes that I have made in past homework, class-work and exams when I've procrastinated in my studying.
- 9. I think about how disappointed others (family/friends) will be if I do poorly in mathematics.
- 10 I think about why I am doing mathematics e. g. about my future plans.

4.4.3.4 Volitional Component Inventory (VCI)

In paragraph 3.4.1 volitional strategies were listed and explained. In the empirical survey the Volitional Competence Inventory (VCI) developed by Kuhl and Fuhrmann (1998) is used as a tool providing learner information on the functional components of volition. The VCI instrument is divided into eight main factors each with three or more sub-scales. The eight factors are listed as follows:

- 1 How learners handle mathematical goals i.e. goal maintenance
- 2 Whether learners remember at appropriate times which mathematical tasks are to be completed at that time
- 3 How learners start work planned
- 4 How easy it is for learners to fully concentrate on difficult mathematics problems
- 5 Which thoughts occupy learners' minds while occupied with difficult mathematics problems
- 6 What feelings and moods do learners experience while doing difficult mathematics tasks
- 7 How hard is it for learners to adjust to new mathematics situations and demands
- 8 How learners react while experiencing setbacks in a challenging mathematical undertaking.

The details of the VCI instrument with sub-scales and some item examples follow:

For goal maintenance, included are four sub-scales namely effort avoidance, reactance, self-control pressure and spontaneity. The items included are:

- 1 Preferring to do things that can be done without much effort.
- 2 Struggling against the expectations others have of me.
- 3 I simply force myself to do the problem.
- 11 Imposing discipline on myself.
- 19 I tell myself "you have to".

To determine whether learners remember at appropriate times which mathematical project are to be completed at that time, the three sub-scales are decision control, intention monitoring and strategic intention control. The included items are:

- 29 Being able to arrive at a decision quickly, if necessary.
- 34 Being able to arrive at a decision when time is short.
- 37 Being afraid of forgetting what I intended to do.

- 40 Carrying things with me to remind me of what I intend to do.
- 41 Telling myself all the things I want to do.
- 50 Using memory aids to ease the burden on my mind.

To investigate how learners start on work planned, the five sub-scales are lack of energy, planning, initiating, external control and goal neglect. Some examples of items as used are:

- 58 Feeling too defeated to get started right away.
- 59 Explaining the necessary steps to myself.
- 60 Starting without hesitation.
- 61 Getting going only when time becomes short.
- 62 Feeling too listless to even get started.

To determine how easy it is for learners to fully concentrate on difficult mathematics problems the following five sub-scales were used: conscious attention control, arousal control-up, implicit attention control, attentional- distractability and arousal control-down. Item questions included were:

- 103 Picking out only the essentials to focus on.
- 104 Being really alert only after a difficulty arises.
- 105 Instructively paying attention to anything that is important for reaching my goal.
- 106 Having a hard time concentrating.
- 107 Becoming quite calm when being excited would hinder me.

To determine which thoughts occupy learners' mind while occupied with difficult mathematics problems, the five sub-scales are of self-determination, volitional self-efficacy, mastery, introjection tendency and volitional optimism. Some examples of item questions are:

- 125 Sensing that I am doing something of my own free will.
- 126 Thinking that I have what it takes.

- 127 Experiencing an intense and pleasant feeling of taking action.
- 129 Being afraid of losing others' good will if I don't come through on a project.
- 130 Being certain that it will all come out all right.

To detect what feelings and moods learners experience while doing difficult mathematics tasks, the following five sub-scales were used: fear of failure, emotion control, emotional distractability, motivation control and alienation. Some item questions used are:

- 174 Thinking of the unpleasant consequences of not having done the homework.
- 175 Doing something that helps me to get rid of an unpleasant mood that is blocking me from progressing towards a goal.
- 176 Having a hard time resisting a tempting distraction.
- 177 Thinking about the positive aspects of a goal when my determination to persevere weakens.
- 178 Feeling as if there's a lot to dislike about the project and nothing to gain from it.

To investigate how hard it is for learners to adjust to new mathematics situations and demands, the three sub-scales used are shift costs action, shift-costs cognitive aspects and failure control. Some of the included item questions are:

- 203 Avoiding getting involved in more than one thing at a time.
- 204 Only slowly perceiving what is important in a changed situation.
- 205 Being quick to learn from criticism.

To determine how learners react while experiencing setbacks in a challenging mathematical undertaking, the following five sub-scales are positive goal fantasies, emotional perseverance inhibition, reinforcing self-evaluation, emotional perseverance rumination and self-rewarding. Some item questions are:

- 232 Fantasizing about how good it will feel to have achieved the goal.
- 233 Finding it hard to start all over again after a failure.

- 234 Looking at all the things I have already accomplished.
- 235 Immediately having to think of past failures after a setback.
- 236 Taking a break after having achieved something difficult.

4.4.3.5 Observations

Lesson observations were made to capture the learning context in classes. The observation schedule included taking note of the following items: mathematics topic, lesson planning and objectives, homework check, learner participation and engagement, teacher assessment style, lesson conclusion, medium of instruction as well as the teaching style (see paragraph 5.2).

4.4.4 Procedure

Permission to carry out empirical research work in some schools in the Rustenburg district was sought first with the Education District Manager and the respective Circuit Managers. The schools to be involved in this survey were labelled

- 1 School R
- 2 School T
- 3 School S
- 4 School K

Arrangements were further finalised with the School Principals and affected mathematics educators of grade 10 in February 2003.

The first part of the empirical survey involved learners taking a Pre-test on mathematics content at the beginning of the second term in order to have some comparative analysis of learner performance on entry from grade 9 and some indication of potential learner achievement. The test was based on the knowledge of work as prescribed in syllabus for grades 9 and 10. The Pre- test was followed by administration of Study Orientation in Mathematics (SOM) questionnaires in all four schools.

The other aspect of the survey in the second term involved mathematics lesson observations and monitoring at the selected schools.

In the third term, what followed was the administration of the Academic Volitional Strategy Inventory (AVSI) together with mathematics content Post-test. A post-test was administered to indicate to what extent learning occurred in individuals at different schools as influenced by different learning context and subsequent study orientation that was experienced in grade 10 while learners deploy of their volitional strategies.

This was then followed by the administration of the VCI. As the VCI questionnaire involved responding to 263 questions that required 2 hours to complete and because of other school planning arrangements, in some schools VCI overlapped into the fourth term which started in October.

Having completed the administration of the empirical survey in schools, all the collected data were then forwarded to Statistics Consultation Services for further processing and analysis.

4.5 SUMMARY OF THE CHAPTER

In conclusion of this chapter, the aims of the empirical study were highlighted, that was to investigate the relationship between volitional strategy use, learning context and learning of mathematics as displayed by performance on tests in grade 10. The other objective was to investigate how study orientation in mathematics interacts with learning context and volition to exert an effect on learner performance in these learners.

In order to reach these objectives six main research questions were posed and sub-divided. Also in this chapter research methodology was outlined, including design, population and sampling. This was followed by an overview of measuring instruments as used in the survey and the detailed procedure of how the survey was conducted.

In chapter 5 results of processed data are recorded, the description of statistical technique used is made and followed by analysis and interpretation of data. The discussion of results follows to check whether they support or disprove formulated questions.

CHAPTER 5

STATISTICAL PROCESSING AND INTERPRETATION OF THE RESULTS

5.1 INTRODUCTION

In chapter 4 the empirical work designed to test the hypotheses was described together with measuring instruments and the administration of tests and scales. In this chapter a report is profiled on the monitoring of schools, data obtained are processed and recorded, then they are analysed and further interpreted and the statistical techniques used in the research are described. Finally the results are discussed.

5.2 REPORT ON MONITORING OF LEARNING CONTEXT AT SCHOOLS

The significant role of learning context has been inferred upon in paragraphs 2.2.3.3 and 3.6.2. In accordance with section 4.4.4 on design and procedure the following recorded observations were made in the four schools during mathematics lessons. A summary of the main teacher and learner cognitive activities is captured under five captions, named firstly, topic, secondly, lesson planning and objectives and thirdly, homework check. The fourth which refers to participation and engagement, is indicative of learner actions as displayed by their ability to staying focused, being committed to the end of the lesson, getting side-tracked by distractions and re-orientation to new situations. The fifth activity leads to lesson ending and conclusion. In addition a conclusive deduction about the teaching style practised during the lesson is made.

5.2.1 Lesson observations at school T in stratum 2

The following are observations of both learners and teacher's classroom activities during mathematics learning and teaching at school T that was made in the period of a week. They are classified with reference to outlined sub-headings as noted:

Lesson topic – Measuring angles and calculating trigonometric ratios.

Lesson planning and objectives – For the three days of observation there was no record of lesson aims and objectives or planning presented or produced.

Homework check – not done, learners were merely asked whether they did homework.

Participation and engagement – learners

Staying focused – Learners were in groups of five or six. In a group about four that is more than half would stay focused in their groups. However one or two learners were inactive and not sure of what to do in their groups. There was interaction amongst learners, as those who were not sure of procedure would ask others.

Commitment to the end of the lesson and competition – Ten or fewer of the learners would concentrate to the end of the lesson despite the noise that erupted towards the end of the period. It was not easy for the teacher to monitor what was going on in the groups. The teacher often praised loudly the groups and members for correct responses. However, when a learner who had been asked a question answered wrongly the whole class would erupt into laughter. At noted incidences during questions and answers, responding learners would be heard exchanging nasty words with others, a behaviour that was not sternly rebuked by the teacher.

Getting side-tracked by distractions – A tendency by other learners to pass comments unrelated to the topic at hand distracted class proceeding. This would provoke exchange of nasty words between learners and create tension.

Re-orientation to new situations – A first attempt on new material was made by two or three learners indicating that half the learners found it difficult to re-orient to a new situation.

Participation and engagement – teacher

The teacher explained vocally instructions to the whole class and did most of the talking during the lesson. The teacher writing and drawing on the board augmented this afterwards. There was no connection of the topic made to the learners' real world or the importance for their future. Not much individual attention was given and learners were not addressed by their names.

It is however regrettable that a triangle diagram was not accurately drawn, co-ordinate axes were not labelled and there was some misconception on mathematics content. For example, a right-angled triangle drawn on the board was wrongly labelled. It had on it a side other than the one meant to be hypotenuse as being the longest side. The teaching style practised is predominantly teacher centred even though learners are in their groups.

Lesson ending and conclusion –

On the days of my visits the three lessons observed had abrupt endings because the teacher ran out of time. This disengaged the learner as no homework or further work was given.

Medium of instruction –

English was used as medium (second language for all learners).

5.2.2 Lesson observations at school R in stratum 1

The noted observations are of classroom activities as displayed by both learners and teachers in mathematics learning and teaching during the week of visit at school R. These are classified with reference to outlined sub-headings as written below:

Lesson topic - Congruency in Geometry

Lesson planning and objectives – Planned guidance by the teacher in handouts were presented as evidence of teacher planning, indicating lesson aims and objectives quite clearly.

Homework check – Was done at the beginning of the lesson by the teacher.

Participation and engagement – learners

Staying focused – the majority of learners would stay focused. Other learners participated by completing work on problems already drawn on the board. It was noted that learners would speak out loud as they worked these riders. A joyous mood prevailed in class and learners freely asked questions even impromptu. When questions were posed half the class spontaneously volunteered and was not shy.

Commitment to the end of the lesson and competition – the majority of learners would concentrate to the end of the lesson, as they were busy writing and answering questions. When their homework exercise books were handed back they did not seem to bother much about their marks even though I reckoned some were low. The teacher praised learners with best performance on homework and correct responses.

Getting side-tracked by distractions - on occasion fewer than five learners would be distracted but the rest seemed to keep their concentration on class events as was evident by first time responses without repetition.

Re-orientation to new situations – most learners smoothly re-oriented to a new situation.

Participation and engagement – teacher

The teacher explained content, highlighted mistakes on homework, directed activities in class, showed connection between the topic on congruency and the previous work. Her work was well structured as indicated by issuing of prepared class handouts. Learners were called out by their names when it came to questions and answers. The teacher gave individual attention to a learner at times and this encouraged them. The teaching style practised was a combination of teacher centred and learner centred approaches.

Lesson ending and conclusion –

The lesson ended well as learners would be asked to re-do and correct mistakes or be reminded about the coming test.

Medium of instruction –

Afrikaans was used as medium (first language for most learners).

5.2.3 Lesson observations at school S in stratum 1

The noted observations are of classroom activities as displayed by both learners and teachers in mathematics learning and teaching during the week of visit at school S. These are classified with reference to outlined sub-headings as written below:

Lesson topic – Algebra solving quadratic equations.

Lesson planning and objectives – done and objectives clear.

Homework check – done at beginning of the lesson by the teacher.

Participation and engagement – learners

Staying focused – the majority of learners would stay focused. A selective group of learners was consistently active in answering questions. A joyous mood prevailed in class and learners freely asked questions.

Commitment to the end of the lesson and competition – the majority of learners would seem to concentrate to the end of the lesson. It seemed they needed to be reminded to copy what was written on the board as the teacher was showing step by step a way of solving quadratic equations. The teacher praised learners who answered correctly while others would applaud. The recipient in return expressed some excitement.

Getting side-tracked by distractions – Learners were rarely being distracted by the environment events outside. This class was quiet and calm.

Re-orientation to new situations – Learners seemed used to familiar methods of rules in dealing with the signs and they did not want to accept the teacher's method of approaching quadratic questions on sums with steps that involved addition and subtraction.

Participation and engagement – teacher

The teacher spent the best part of the lesson explaining and legibly writing important steps on the board. However, there was no connection made to either real life or any knowledge that they knew prior and related to the topic. In

addition the teacher directed activities in class and issued homework. The mood generated by the teacher was quite friendly and welcoming to all class members. The educator seemed to know most of the learners by their names. In addition some learners were given individual attention when stuck with questions. The teaching style practised was predominantly teacher centred even though individual attention was given to some learners.

Lesson ending and conclusion –

The lesson ended well, as learners would be asked to complete homework and were even reminded about the coming test.

Medium of instruction –

English was used as medium (second language for all learners).

5.2.4 Lesson observations at school K in stratum 2

The noted observations are of classroom activities as displayed by both learners and teachers in mathematics learning and teaching during the week of visit at school K. These are classified with reference to outlined sub-headings as written below:

Lesson topic – Definition of trigonometric ratios.

Lesson planning and objectives – done and objectives more or less clear.

Homework check – not done at the beginning of the lesson by the teacher. Learners were merely asked whether they did the homework.

Participation and engagement – learners

Staying focused – about half the class would stay focused without being disturbed in their groups. A learner would be asked to work out problem on board. The learners were in the groups of seven to eight. The roles of learners in their groups were sometimes not clearly defined as three or more learners were inactive in their groups.

Commitment to end of lesson and competition – A total of less than ten in class of 40 would concentrate to the end of the lesson. The teacher mocked those who were wrong. These are those whose response to questions when selected was irrelevant. When a learner who had been asked a question answered wrongly the whole class would erupt into laughter. In some instances the learner whose response was incorrect and who was teased would even exchange unpleasant words with those making remarks. These incidents of laughter and remarks interrupted class commitment and concentration, as learners did not seem to complete the work assigned to them.

Getting side-tracked by distractions – On more than two occasions on different days learners would be distracted by noise from other groups and even noise from outside the class especially when it came to about five minutes towards end of the period.

Re-orientation to new situations – The teacher took pains to convince them about how to work in their chosen groups but the quarrels that erupted and noise indicated that most learners found it difficult to adapt to this new way of co-operative approach.

Participation and engagement – teacher

The teacher explained well, directed activities in class talked when necessary but allowed learners to explore in their groups. However, there was no connection

made between real life and trigonometry. The abstract terms and definitions were conveyed to the learners. The teacher did not seem to know most learners in her class by their names. Not much individual attention was given but group attention was given. Even though learners were in their groups the teaching style was teacher centred.

Lesson ending and conclusion –

The lesson ended abruptly without any clear connection made to the next one; homework was not even given.

Medium of instruction –

English was used as medium (second language for all learners).

5.3 RESULTS

5.3.1 Statistical Techniques

5.3.1.1 Significance of differences

In the empirical survey latent volitional, contextual constructs and study orientation were measured using the VCI, AVSI and SOM respectively.

To be able to compare the scores of different dimensions of the questionnaires and of different groups to each other, means and standard deviations were calculated. The degree of variance in data was calculated by using the coefficient of variance (C V):

$$C V = \frac{\text{Standard deviation}}{\text{mean}} \times 100$$

The canonical correlation between VCI, AVSI scales and SOM fields were determined. In order to determine if correlation was practically significant, effect sizes were used (see Ellis & Steyn, 2003). The Pearson's correlation coefficient, $r \geq 0.36$ indicates medium effect that might be important in practice and correlation $r > 0.5$ indicates large effect that is practically significant. Whilst to determine if difference of scales between the averages of scales between schools were practically significant, the effect size (d) was determined using the formula

$$d = \frac{|\bar{x}_i - \bar{x}_j|}{\sqrt{MSE}} \quad (1)$$

wherein $\bar{x}_1$ and $\bar{x}_2$ are the two means for different schools and MSE is the mean square error of the analysis of variance (ANOVA).

According to Ellis and Steyn (2000), effect size is a measure of the significance of differences. Guidelines for the interpretation of the effect size involves using Cohen's criterion as follows: $0.5 \leq d < 0.8$, medium effect that might indicate practical significance and, $d \geq 0.8$ large effect that is practically significant.

5.3.1.2 Reliability of instruments

Interrelated items may be summed to obtain an overall score for each participant. Chronbach's coefficient alpha estimates the reliability of this type of scale determining the internal consistency of the test or the average correlation of items within the test. As suggested by McCann & Garcia, (1999:7), Cronbach's coefficient Alpha is the preferred measure for evaluating the internal consistency of an instrument. In order to obtain reliability, estimates of VCI, AVSI and SOM items Cronbach's alpha were used. The coefficient alphas computed are tabled as indicated in table 5.1.

Table 5.1 – Cronbach's Alpha for VCI, AVSI and SOM

Volitional strategy	Description of scale label	Cronbach's Coefficient Alpha
VCI		
Goal maintenance	Effort Avoidance (EAV)	0,42*
	Reactance (REA)	0,57
	Self-control Pressure (SCP)	0,60
	Spontaneity (SPO)	0,61
Intention control	Decision control (DEC)	0,71
	Intention Monitoring (IMO)	0,70
	Strategic Intention Control (SIC)	0,79
Initiating and planning	Lack of Energy (LAE)	0,66
	Planning (PLA)	0,62
	Initiating (INI)	0,60
	External Control (XCO)	0,69
	Goal Neglect (GON)	0,65
Attention control	Conscious Attention Control (CAC)	0,67
	Arousal Control-Up (ACU)	0,68
	Implicit Attention Control (IAC)	0,59
	Attentional –Distractability (ADI)	0,69
	Arousal Control-Down (ACD)	0,67
Self-determination, volitional self efficacy and optimism	Self-determination (SEL)	0,73
	Volitional Self-Efficacy (VSE)	0,77
	Mastery (MAS)	0,74
	Introjection tendency (IOJ)	0,70
	Volitional Optimism (OPT)	0,76

Emotion control and motivation control	Fear Of Failure (FOF)	0,62
	Emotion Control (EMC)	0,66
	Emotional Distractability (EDI)	0,66
	Motivation control (MOC)	0,65
	Alienation (ALI)	0,48*
Failure control and shiftcosts cognitive aspects	Shift costs Action (SAC)	0,73
	Shiftcosts Cognitive Aspects (SCO)	0,64
	Failure Control (FCO)	0,58
Emotional perseverance inhibition and rumination	Positive Goal Fantasies (PGF)	0,72
	Emotional Perseverance Inhibition (EPI)	0,68
	Reinforcing Self-Evaluation (RSE)	0,69
	Emotional Perseverance Rumination (EPR)	0,69
	Self-Rewarding (RWD)	0,65
AVSI		
SEE	Self-efficacy Enhancement (SEE)	0,79
SRA	Stress- Reducing Actions (SRA)	0,80
NBI	Negative Based Incentives (NBI)	0,62

SOM	Fields	
ATT	Attitudes	0,80
ANX	Anxiety	0,68
STH	Study Habits	0,81
PRS	Problem Solving	0,79
STM	Study Milieu	0,69
INP	Information processing	0,74

Cronbach's coefficient alpha values that were greater than 0.5 for the particular instrument scale were considered reliable while for alpha values less than 0,5 the instrument was not reliable. Thus the instruments used could be regarded as having sufficient internal reliability for most of the scales of VCI, and all of the scales for AVSI and SOM. The two scales indicated with (*) of the VCI instrument that were not reliable are effort avoidance (EAV) and alienation (ALI). These two scales will be excluded from further analysis.

5.3.1.3 Normality and the population

The Central Limit Theory indicates that the means of a large sample will display normality. The means procedure for this population attests correlation between both means for all the variables that were used in the VCI, AVSI and SOM. The means and medians are indicated below in table 5.2.

Table 5.2 -The means and medians of each scale label

Scale label	Mean	Median
Reactance	26.30	25.00
Self-control pressure	31.87	31.00
Spontaneity	28.65	30.00

Decision control	36.31	35.00
Intention monitoring	36.97	38.00
Strategy intention control	30.95	32.00
Lack of energy	26.93	28.00
Planning	29.93	29.00
Initiating	27.65	28.00
External control	24.65	24.00
Goal neglect	24.03	23.00
Conscious attention control	31.50	32.00
Arousal control-up	33.93	33.00
Implicit attention control	31.50	32.00
Attention-distractibility	30.15	30.00
Arousal control down	33.93	32.00
Self-determination	37.70	37.00
Volitional self-efficacy	30.29	31.00
Mastery	39.54	38.00
Introjection tendency	27.37	26.00
Volitional optimism	31.67	31.00
Fear of failure	29.08	28.00
Emotion control	32.31	32.00
Emotional distractibility	36.01	38.00
Motivation control	29.54	29.00
Shift cost action	44.63	47.00
Shift cost cognitive aspects	33.46	34.00
Failure control	33.93	37.00
Positive goal fantasies	33.39	34.00
Emotional perseverance inhibition	33.64	34.00
Reinforcing self-evaluation	31.99	33.00
Emotional perseverance rumination	36.26	35.00
Self-rewarding	32.40	31.00

Self-efficacy enhancement	44.91	44.00
Stress reducing action	28.50	30.00
Negative based incentives	24.99	25.00
Attitudes	37.66	39.00
Anxiety	37.11	38.00
Study Habits	33.90	34.53
Problem Solving	30.01	30.80
Study Milieu	37.90	37.69
Information processing	39.37	39.00

From table 5.2 one can see that the means and medians correlate closely, indicating normality in the population.

5.3.2 Results and discussion

5.3.2.1 Results: relationship in learner perceptions towards mathematics study orientation and volitional strategy use

In section 5.3.1 it was indicated that canonical correlation between AVSI, VCI and SOM was determined and use was made of the Cohen criterion to interpret results. Table 5.3 demonstrates the nature of the relationship observed.

Table 5.3 Canonical correlation between AVSI, VCI, and SOM

	Canonical correlation	p	Effect
AVSI vs SOM	0.36	<.0001	Medium
VCI vs SOM	0.55	0.0123	Large

The canonical correlation value of 0.36 obtained suggests a possible association between AVSI and SOM. The results also suggest a correlation of the practical importance between the aspect of volitional component inventory and study orientation.

5.3.2.1.1 Deduction about the relationship between study orientation and volitional strategies in response to research question 1.1

Are there any significant differences in the perceptions of sampled groups from the study population with regard to volitional strategy use in mathematics in grade 10 and study orientation?

The large effect correlation between VCI and SOM results reaffirms those learner perceptions with regard to the use of volitional strategy signal impact of significance on study orientation. The research by Kuhl and Fuhrmann (1998:23-24) verifies these findings. In section 3.4 and 3.6.2.1, in agreement with literature review, volitional strategies are implicated in goal and self-maintenance through self-control and self-regulation. Appropriate study orientation lead learners to be involved in questioning, inductive and analytical reasoning and speaking up in class, Tamsin (2002:179) suggests and these entail volitional responses.

5.3.2.2 Results: *The comparative influence of study orientation on mathematics performance in schools within two different strata*

Study orientation and performance at school R in stratum 1

The results shown below for school R as obtained by the SOM instrument indicate some correlation which can be of practical significance in two fields of attitudes and information processing.

Table 5.4 – Pearson's correlation coefficient (r) for school R on T₂

Fields	r	p	Effect size
Attitudes	0,36	0.009	Medium
Information processing	0,35	0.011	Medium

As indicated in table 5.4 for T_2 there is medium effect of attitudes on mathematics performance. This indicates that more learners who generally express approaching mathematics well and consider it to be a useful subject and therefore continue to work in it even if they find it uninteresting or boring performed well on T_2 .

How learners perceived their own way of information processing during mathematics activities had some moderate effect to T_2 performances. Information processing entails correct application of theorems and formulae. Thus with reference to these learner results the significance of information processing is as inferred in accordance with research findings by Kanfer and Ackerman (1989) referred to in 2.4.4.6.

Study orientation and performance at school K in stratum 2

Table 5.5 – Pearson’s correlation coefficient (r) for school K

Fields	r	p	Effect size
Attitude	0,32	0 . 014	Medium

In table 5.5 the results for school K in stratum 2 also indicate the possibility that could be of practical significance between attitude and T_2 performances.

5.3.2.2.1 Deduction about relationship between study orientation and performance in response to research question 1.2

Are there any significant differences in the perceptions of sampled groups from a study population with regard to study orientation in mathematics in grade 10 as determined by learner performance?

The learners in schools R and K who were involved in the research revealed the influence of attitudes on their mathematics performance. Furthermore, for school R as reflected by learner perceptions, the way learners believe they process information is of some significant effect on their performance. As these are both fields of SOM, the results are in agreement with the claim made in section 2.4.4 quoted from Maree *et al.* (1997:3) and Du Toit (1970) about that association between aspects of study orientation in mathematics and academic achievement. Don Galagedera *et al.* (2000:683) also find in South Africa a significant (but low) correlation between attitudes towards mathematics and mathematics scores for standard ten learners.

5.3.2.3 Results: relationship between learner perception about their volitional strategy use and performance

With reference to section 5.3.1, Pearson's correlation coefficients were used to determine the relationship between the use of volitional strategies and T₂ performance in the four schools. The direct relationship in volitional strategy used by learners was observed at school T in stratum 2 and at school R in stratum 1 as indicated respectively in table 5.6 and 5.7 for specified volitional fields.

Learner perception of volitional strategy use and performance at school T in stratum 2

Table 5.6 – Pearson's correlation coefficient (r) with T₂ for school T

SCALE	r	p	Effect size
Lack of energy	-0,41	0.0002	Medium
Goal Neglect	-0,39	0.0004	Medium

In table 5.6 results from the VCI instrument indicate that for T₂ the lack of energy scale correlates negatively with medium effect size difference on test performance that might be of practical significance. This implies that more learners who indicated increased lack of energy performed poorly. Reference is made to section 3.4.1 on literature review in

agreement with the role of self-regulation volitional strategies on mathematics activities. An amount of energy is necessary for mind engagement during mathematics activity, therefore lack of energy has an ultimate effect on performance.

There is also some negative correlation between goal neglect scale and performance for test two. The medium effect of goal neglect might be of practical significance to performance. This implies that learners who indicated high goal neglect performed unsatisfactorily. The result is in agreement to what is suggested in section 3.4.2 about the role of self-control volitional strategies.

Learner perception of volitional strategy use and performance at school R in stratum 1

Table 5.7 – Pearson’s correlation coefficient (r) with T₂ for school R

SCALE	T ₂ r	p	Effect size
VCI			
Shift Cost Action	0,43	0.007	Medium
Shift Cost Cognitive	0,37	0.019	Medium
Failure Control	0,49	0.002	Large
Emotional Perseverance Inhibition	-0,52	0.012	Large
Emotional Perseverance Rumination	-0,48	0.025	Medium

The VCI school R results as displayed in table 5.7 indicates correlation for five scales as shown. There is a large practically significant effect between failure control scale and T₂ performances. That is, most learners who indicated always learning from mistakes quickly and without hesitation as well as being able to change behaviour immediately when someone points out their mistakes performed better. The results concur with effect of self-control volitional strategy as highlighted in section 3.4.2.4.

There is some large negative effect that is to be practically significant for T_2 between emotional perseverance inhibition and test performance. That is, learners who indicated always feeling internally paralysed by some fear of failure and who lose all their energy when threatened by failure had a low test mark. In section 3.4.1.3 the significant role of emotional control in influencing performance was suggested from the literature review.

In the above results shift cost action and shift cost cognitive aspect could be of slight practical significance on mathematics test performance. This implies that learners who indicated always being slow to perceive what is important in a changed situation and who found it hard to reorient to new situations performed poorly. Also learners who found it difficult to shift back and forth between activities and change from usual actions to new ones performed lowly. The importance of self-regulation was indicated in section 3.4.1.

In addition a direct link of medium effect was observed between emotional perseverance rumination and performance for T_2 in school R. This is in line with the suggestion in section 3.4.1.3 about emotional sentiments during volition control. As stated, learners who always brood after failure and are unable to escape worrying thoughts are likely to perform inadequately.

Table 5.8 – Pearson’s correlation coefficient (r) with T_2 for school R

SCALE	r	p	Effect size
AVSI			
SEE Self-Efficacy Enhancement	0,38	0.005	Medium

Results from the AVSI instrument as indicated in table 5.8 show that there is some correlation between self-efficacy enhancement scale and T_2 performances. The medium effect that can be of practical significance is in concurrence with section 3.4.2.1 on self-control volitional strategies about intention control and goal striving. This implies that

learners who always think about the goals they have set for themselves, how current performance may affect their future and think about their own strengths and resources they draw upon to help them with difficult problems perform well. Self-efficacy enhancement augments test performance.

5.3.2.3.1 Deduction about relationship between volitional strategies and performance in response to research question 1.2.

Are there any significant differences in the perceptions of sampled groups from the study population with regard to volitional strategy use in mathematics in grade 10 as determined by learner performance?

Since according to results of the survey for the learners who were involved failure control and emotional perseverance inhibition are of possible significant effect to test performance there is reason to believe in the existence of a relationship between some volitional strategies as used by these learners and their performance. This is in harmony with the assertion made in section 2.6.3 about volition control that it influences cognitive engagement and strategic regulation of cognition and mediates between the intention to learn and the use of learning strategies (Corno, 2000:659).

5.3.2.4 Results: relationship between learner perceptions about study orientation and learning context

The mean and standard deviations were used to determine the learner perception on study orientation between schools in different strata. Table 5.9 below indicates such a comparative analysis between schools.

Table 5.9 – Comparison between different school means and standard deviations for study orientation field

Study orientation	Comparison between schools	Mean	Standard deviation	Coefficient of variance
Attitude	School T	34.74	11.82	34
	School R	35.82	9.02	26
	School S	41.54	7.90	19
	School K	38.12	8.78	23
Anxiety	School T	34.44	7.34	21
	School R	38.54	7.71	20
	School S	40.31	7.56	19
	School K	35.32	7.96	23
Information processing	School T	37.64	8.10	21
	School R	37.72	8.45	22
	School S	43.07	9.88	23
	School K	38.35	9.68	25
Study milieu	School T	34.15	7.36	22
	School R	40.38	8.30	21
	School S	41.91	7.74	18
	School K	35.60	7.69	22

The comparative effect difference of learner perceptions about study orientation was obtained from learners exposed to different school contexts. As outlined in section 5.3.1.1, the means square error and formula for effect size d were used. These results are indicated in table 5.10 below.

Table 5.10 - Comparative effect sizes, d for study orientation fields between schools

Study orientation field	Comparison between schools	d- value	Effect size
Attitudes	T vs. R	0,11	Small
	T Vs S	0,71	Medium
	R Vs S	0,60	Medium
	R Vs K	0,24	Small
Anxiety	T Vs R	0,54	Medium
	T Vs S	0,77	Medium
	R Vs S	0,23	Small
	R Vs K	0,42	Small
Study Habits	T Vs R	0,10	Small
	T Vs S	0,54	Medium
	R Vs S	0,43	Small
	R Vs K	0,09	Small
Study milieu	T Vs R	0,81	Large
	T Vs S	1,00	Large
	R Vs S	0,20	Small
	R Vs K	0,62	Medium
Information processing	T Vs R	0,00	
	T Vs S	0,60	Medium
	R Vs S	0,59	Medium
	R Vs K	0,07	Small

The results of learners that were involved in this research indicate large effect differences in the study milieu of learners at schools R and T and even between schools T and S. There is also a medium effect difference in attitudes, anxiety, study habits, study milieu

and information processing in learners who participated in the research between schools T and S as well as school R in comparison to schools S, T and K.

5.3.2.4.1 Deduction about the relationship between learning context and study orientation

Are there any significant differences in study populations with regard to learner perceptions about study orientation and prevalent context in mathematics in grade 10?

The large effect difference between schools R and T as well as schools T and S was displayed in learner perceptions of the study milieu aspect of study orientation and context as shown in table 5.10. In addition other aspects of study orientation like attitudes, anxiety, study habits and information processing exhibited medium effect difference between schools as indicated in table 5.10. Therefore, learning context at schools seems to have some interactive effect on study orientation that can be used to explain differences in learner performance between schools R and T, S or K, as well as performance differences between schools T and S.

5.3.2.5 Results: the relationship between learner perception about use of volitional strategies and learning context

In order to establish the nature of the relationship between the use of volitional strategies in different types of learning contexts, the calculated means and standard deviations are used. Table 5.11 gives an indication of the use of volitional strategies in mathematics classes as perceived by learners who perform differently and are exposed to a different type of context.

Table 5.11 – Volitional strategies, means and standard deviations of schools T, R S and K

Volitional strategy	Comparison between schools	Mean	Standard deviation	Coefficient of variance
Self-control pressure	School T	35.48	6.27	18
	School R	30.05	5.08	17
	School S	31.40	7.60	24
	School k	30.96	7.34	24
Intention monitoring	School T	38.64	6.87	18
	School R	37.96	8.71	23
	School S	36.28	7.86	22
	School K	34.41	9.81	29
Lack of energy	School T	25.23	6.52	26
	School R	28.43	5.74	20
	School S	26.28	7.37	28
	School K	27.54	6.66	24
Planning	School T	31.18	6.30	28
	School R	27.49	5.06	18
	School S	31.36	7.57	24
	School K	30.29	6.70	22
Initiating	School T	28.98	6.64	23
	School R	25.57	5.80	23
	School S	28.14	7.09	25
	School K	28.60	6.15	22
Attentional distractability	School T	28.12	6.23	22
	School R	35.10	6.88	20
	School S	27.94	7.40	26
	School K	27.92	7.27	26

Volitional self-efficacy	School T	32.72	7.48	23
	School R	26.26	10.40	40
	School S	31.79	8.82	28
	School K	31.62	7.99	25
Emotional control	School T	31.09	6.49	20
	School R	37.19	9.55	26
	School S	29.46	9.26	31
	School K	30.19	7.85	26
Shiftcost cognitive aspect	School T	32.87	6.70	28
	School R	35.03	15.29	44
	School S	34.23	8.52	25
	School K	30.96	8.47	27
Failure control	School T	35.81	7.05	20
	School R	31.58	13.64	43
	School S	34.92	8.19	23
	School K	33.62	8.94	27
Emotional perseverance rumination	School T	34.83	6.46	20
	School R	42.35	7.68	18
	School S	33.87	7.24	21
	School K	34.11	7.91	23
Self-efficacy enhancement	School T	47.85	6.51	14
	School R	41.50	8.57	21
	School S	47.02	7.52	16
	School K	43.12	8.51	20
Stress reducing actions	School T	33.37	6.40	19
	School R	21.36	6.67	31
	School S	31.08	6.67	21
	School K	29.22	7.42	25

Negative based incentives	School T	26.27	4.09	16
	School R	22.75	4.77	21
	School S	26.58	4.36	16
	School K	24.51	5.42	22

From table 5.11 the comparative means indicate that the named volitional strategies are used with some variance in these schools. The smaller the value for the standard deviation, the more concentrated or homogeneous the data are (Berenson & Levine, 1966: 106 – 123). Therefore the above results are indicative of the diverse use of the volitional strategies by learners at four schools. The volitional strategies are namely self-control pressure, intention monitoring, lack of energy, planning, initiating, attentional distractability, volitional self-efficacy, emotional control, shift-costs cognitive aspects, failure control, emotional perseverance rumination, self-efficacy enhancement, stress reducing actions and negative based incentives.

DISCUSSION

Self-control pressure

The instrument scale measured the perceived self-expressed willingness to take on an unpleasant or difficult mathematical problem or even refusing to tackle it.

Comparison among differently performing school groups indicates a difference in self-control pressure or goal maintenance. The biggest difference among the four schools is that which occurs at school T in stratum 2 where mean is 35.48. Learners at school T performed better with regard to test content performance than those at schools S and K in stratum 1 and 2 respectively. With regard to self-control pressure as dimension, there is also a difference of medium effect between the groups, meaning that the dimension seems to be of importance for performance as well.

Intention monitoring

The volitional inventory determines how learners perceive the importance of actually doing mathematics assignments in line with decision taken. This implies that learners remember at the appropriate time which mathematics tasks are to be completed at that time and which tasks do they not succeed in doing.

The biggest difference among the four schools occurs at school T that has a mean of 38.64. With reference to intention monitoring and effect difference between the groups there is a medium effect difference at school K. These suggest that the dimension is of importance for performance.

Lack of energy, planning and initiating

The volitional component inventory with reference to the three scales determines the perceived difficulty experienced to actually start working on what is planned, for example preparing for a mathematics exam. Do learners start working on mathematics tasks successfully without difficulty or can they not get going or do so only under time pressure?

School R in stratum 1 has the largest means value of 28.43 for lack of energy and school T has the largest mean value of 28.98 for initiating. In addition there are medium effect differences between schools R and T as well as between schools R and S. Therefore mathematics learners' lack of energy and ability to initiate influence their mathematics performance.

Attentional distractability

The instrument in this regard measures the perceived difficulty to keep learner attention or concentration on uninteresting mathematics problems because they are too excited, too

nervous or because their thoughts wander. And as a result learners end up neglecting difficult or uninteresting mathematics problems.

The biggest mean value is 35.10 obtained for learners at school R in stratum 1, followed by a mean value of 28.12 for learners at school T in stratum 2. Moreover, with reference to this scale there is large effect difference between school R and both schools T and S, thus indicating that attentional distractability is of practical significance to mathematics performance.

Volitional self-efficacy

The volitional component inventory instrument on volitional self-efficacy determines how learners perceive themselves when occupied with difficult or uninteresting mathematical tasks, whether learner thoughts or sensations are positively tuned as in being hopeful and optimistic, or learners become flooded with negative feelings like doubts and uneasiness.

The highest mean value of 32.72 is experienced by learners at school T. Learners at school R for this scale dimension have a mean value of 26.26 but with a high standard deviation of 10.40, suggesting that the results may not be altogether reliable. However, there seems to be a medium effect difference for volitional self-efficacy between school R and both schools S and K that can suggest a mild influence of the scale on mathematics performance.

Emotional control

The instrument determines the perceived learner feelings and moods while doing difficult or uninteresting mathematics problems, whether learners turn negative and simply feel inclined to do other things or whether they apply strategies that make them stick it out or they imagine what makes it even harder to stay on mathematics tasks.

School R has the highest mean value of 37.19 for emotional control, followed by mean a value of 31.09 for school T. In addition, with reference to effect difference, there is a large effect difference for emotional control between school R and both S and K. There is also a medium effect difference for emotional control between schools R and T. Therefore emotional control seems to be of significant influence to mathematics performance.

Shift-costs cognitive aspects and failure control

The instrument in this regard determines mathematical learners' perception on hardness to adjust to new situations and demands, especially if learners have been occupied with one thing for a long time. Do learners succeed in disengaging themselves from the old routine and in adjusting to a new one with or without errors and criticism?

The results of school T indicate a bigger mean value for both the shift cost cognitive aspect and failure control of respectively 32.87 and 35.81 with low standard deviation. The mean value obtained for the same scale dimensions for learners at school R are respectively 35.03 and 31.58 but with large standard deviations of 15.29 and 13.64 and therefore are less reliable. On the whole it does seem that the dimension might be of some effect to mathematics performance as those high mean values are from schools with higher performance.

Emotional perseverance rumination

The volitional component inventory instrument with reference to emotional perseverance rumination indicates learner perceived view about their own reactions in a challenging mathematical problem undertaking when they suffer setbacks or if the whole problem goes wrong. The instrument determines whether learners are completely stalled and have to keep on thinking about their mistakes or whether they are spurred on by mistakes to become more successful.

The results for learners at school R have the highest mean value of 42.35, followed by school T with a value of 34.83. Furthermore, the effect difference for emotional perseverance rumination indicates a large effect difference which signals significant influence of this dimension on mathematics performance.

Self-efficacy enhancement, stress reducing actions and negative based incentives.

The three-factor structure of academic volitional strategy inventory entails self-report about how mathematical learners manage potentially disruptive emotional states during self-regulatory learning. These include how learners garner effort and persistence to tackle mathematics tasks. In addition, the self-reports are about learner reassuring thoughts that enhance self-efficacy, and calming actions and thoughts about negative consequences of poor performance.

The highest mean values are as follows: 47.85 for self-efficacy enhancement observed at school T, 33.37 for stress reducing factors observed at school S. The lowest mean value is 22.75 for negative based incentives observed at school R. Moreover, the effect difference is medium between self-efficacy enhancement for learners at schools R and S but large between schools R and T. Therefore self-efficacy enhancement can be of significant effect to mathematics performance. Similarly there is a medium effect difference for stress reducing actions for learners at schools T and K but a large effect difference between learners at school R and the other three. Stress reducing actions as practised by these learners seem to have significant impact on mathematics performance. For negative based factors a medium effect difference is observed between learners at schools R and T while a large effect difference is observed between schools R and S. Thus negative based incentives have a significant influence on mathematics performance.

In conclusion the results for these learners verify that volitional strategies are deployed differently by these learners at their schools. The difference in use of volitional strategy is attributed to existing contextual differences at the schools

Furthermore, the comparative effect difference of some volitional strategies used against learning context at schools as outlined in section 5.3.1.1 derived at by using the means square error and formula for effect size d is indicated in table 5.12.

Table 5.12 - Volitional strategies and school's comparative effect size, d

Volitional strategy	Comparison between schools	d- value	Effect size
Attentional Distractability	R Vs. T	1,01	Large
	T Vs S	0,03	Small
	T Vs. K	0,03	Small
	R Vs S	1,03	Large
	R Vs K	1,03	Large
Emotion control	R Vs T	0,72	Medium
	T Vs S	0,19	Small
	T Vs K	0,11	Small
	R Vs S	0,91	Large
	R Vs K	0,83	Large
Emotion Perseverance Rumination	R Vs T	1,03	Large
	T Vs S	0,13	Small
	T Vs K	0,10	Small
	R Vs S	1,16	Large
	R Vs K	1,13	Large
Self-Efficacy Enhancement	R Vs T	0.82	Large
	T Vs S	0,11	Small
	T Vs K	0,61	Medium
	R Vs S	0,71	Medium
	R Vs K	0,21	Small

Stress Reducing Actions	R Vs T	1,78	Large
	T Vs S	0,34	Small
	T Vs K	0,62	Medium
	R Vs S	1,44	Large
	R Vs K	1,16	Large
Negative Based Incentives	R Vs T	0,76	Medium
	T Vs S	0,07	Small
	T Vs K	0,38	Small
	R Vs S	0,83	Large
	R Vs K	0,38	Small
Volitional Self-Efficacy	R Vs T	0,73	Medium
	T Vs S	0,10	Small
	T Vs K	0,12	Small
	R Vs S	0,62	Medium
	R Vs K	0,60	Medium
Self-control Pressure	R Vs T	0,76	Medium
	T Vs S	0,62	Medium
	T Vs K	0,69	Medium
	R Vs S	0,21	Small
	R Vs K	0,14	Small
Planning	R Vs T	0,58	Medium
	T Vs S	0,03	Small
	T Vs K	0,14	Small
	R Vs S	0,60	Medium
	R Vs K	0,43	Small
Initiating	R Vs T	0,53	Medium
	T Vs S	0,13	Small
	T Vs K	0,06	Small
	R Vs S	0,40	Small
	R Vs K	0,47	Small

Intention monitoring	R Vs T	0,08	Small
	T Vs S	0,28	Small
	T Vs K	0,51	Medium
	R Vs S	0,20	Small
	R Vs K	0,43	Small
Interjection tendency	R Vs T	0,56	Medium
	T Vs S	0,03	Small
	T Vs K	0,09	Small
	R Vs S	0,59	Medium
	R Vs K	0,47	Small

DISCUSSION

Table 5.12 indicates the effect size difference of identified volitional strategies between the four schools. The difference in effect size indicates that the named volitional strategies are used differently by learners at these schools.

5.3.2.5.1 Contextual differences between the four schools that impact on learner volitional strategy use

5.3.2.5.1.1 School R context versus context at schools T, S and K

The contextual factors at school R versus identified factors at T, S and K that may be attributed to large significant effect difference on named volitional strategies are outlined in the next paragraph.

The significant large effect difference in attention distractibility between school R and the three other schools may be attributed to the difference in teachers' lesson planning and co-ordination as well as to continuity of lessons and envisaged connection to learners' future plans. Attention is augmented by the generation of learner interest. In addition the relatedness and relevancy of what was being taught that was facilitated by the detailed

preparation by the educator in school R may also account for difference in attentional distractibility between schools. Furthermore, at school R the educator issued handouts and made extensive use of illustrative and elaborate diagrams that facilitated cognitive shift actions which re-oriented learner to new situations. This influenced learners to display extended concentration in class, as mathematics lessons were well planned and co-ordinated throughout. However, in the other three schools there was not much evidence of extensive teacher planning and preparation as no records were displayed. Therefore differential planning and the use of illustrative diagrams impact on learner attention distractibility.

The large effect difference in emotional perseverance rumination between learners at school R in comparison to learners at schools S, T and K may be accounted for through the discrepancy in employing punitive means. Despite the teacher at school R being strict on discipline, no over emphasis on punitive measures that were mind-boggling were applied for a long time. In schools K and T the educator would on occasion stress the stupidity and the incorrectness of learner response, while at school R the teaching environment was rather persuasive as learners were not ridiculed or punished for incorrect responses by the teacher. This contributed to learner failure control. The support that is given at school R even when learners have committed mistakes strengthens failure control. In addition negative peer comments and teacher remarks may prompt a learner to be plagued by worry during mathematics learning. In schools K and T the teachers did not properly exercise discipline and control, as it was common practice by some learners to pass disruptive comments during lessons. This added emotional pressure on learners by increasing the fear of being laughed at while making attempts in answering. This created unpleasant feelings, which reduced their happiness and did not promote risk taking in class. The anxiety aroused as a result of self-pity during homework check affected how learners enjoyed the rest of mathematics lessons. The teacher's punitive measures when learners committed mistakes, handling approach and peer remarks contributed to emotional perseverance rumination.

In addition, emotional perseverance rumination difference between schools can be accounted for by the difference in how the educator creates some positive and encouraging contexts through lesson preparation and planning. Inadequate preparation leads to less exposure to alternative methods of solving mathematics problems but reinforces only rigid methods as outlined in the mathematics text-book. Moreover, in school R planned assessment and remedial work were more frequent, giving learner the opportunity to improve on individual performance and hence learners' awareness of their own potential to improve and succeed increased. In other schools assessment was not as regular. As a result of spaced time interval, low performing learners tend to live more with failure and minds dominated by lack of awareness of their own ability as well as inadequate knowledge. This leads to a feeling of learner hopelessness and more brooding over failure. The planned different ways of assessing determined by the teacher in school R may as well account for the difference in effort exertion by learners. In addition, this frequent assessment, an indication of performance attainment and remedial support given, contribute towards emotional state. The more frequently learners are assessed, the more-awareness of knowledge potential in individual strengths and resources increases. Thus teacher preparation, planning and ongoing learner assessment influences emotional perseverance rumination.

The way learners interacted in their groups during discussions may account for the large stress reducing action difference between schools. Intolerant behaviour was noted during observations especially at school K. The interrupting way of communication as experienced during questioning and answering in seeking help affects the way learners could be stressed. The individual's stress state difference is determined by self-discipline that dictates interactive ability to make proper use of listening and response skills.

At school R, during questions, about half the class would spontaneously respond by show of hands. Their number was higher in comparison to learners that responded at other schools. The disparity displayed through voluntary responses may be used to explain the difference in learner initiating behaviour observed between schools R, T and to some extend school K. The displayed personal initiatives to attempt answers on the board thus

being actively involved during lessons suggest a tendency of self-conscious directed actions that also are in line with good classroom intentions. Furthermore, learner awareness of what is at stake and the possible reward behind mathematics success within time constraints may lead to a difference in initiating behaviour and to explain observed differences. At school R, which is a technical institution, learners need mathematics knowledge as a tool to use in the technical subjects. To learners at school R mathematics has more value attached to it. As a result the degree to which they initiate activities is different. Thus the voluntary response attitude contributes to increased need for mathematics

There is a medium effect difference on self-efficacy enhancement between learners at school R and learners at the three other schools. In the classroom where the mood was pleasant, learners willingly and freely responded to questions without fear of ridicule as in school R. This may account for the volitional self-efficacy difference. The willingness and spontaneous response attitude as displayed by school R learners develop from build-in learner confidence in their mathematical ability that grows into volitional self-efficacy. When learners talk aloud while answering questions on the board they increase their meta-cognition control and enhance their own self-efficacy. This volitional self-efficacy is strengthened by prompt teacher feedback after an attempt on the board, expressed class reaction and response in praise to a correct answer. Speedy corrective teacher support and feedback further promote learner cognitive responses. In other schools there was a lack of individual learner encouragement and opportunity for learners to display their own strengths. This reduced mathematical learner confidence and faith in their own endurance. Encouraging comments in a pleasant classroom mood and individual learner attention by the teacher may add to a difference in developed volitional self-efficacy.

The medium effect difference in planning between school R and the others is attributed to individual attempts. At school R learners were frequently exposed to making first individual attempts in answering questions on the board and were often exposed to different ways of solving problems. As learners attempted answering problems on the

board there was some implied difference on how learners were able to go over details in their minds during the planning approach. When learners volunteered to make attempts on the board their ability to plan an approach on questions improved. Volitional responses further contributed to their own planning; goal setting that enhanced self-efficacy. Furthermore, with reference to learner attempts, individual attention was increased as the teacher passed comments immediately after a learner completed the question. In other schools an inadequate and deficient teacher monitoring style of learner groups effected mainly through open general teacher remarks impeded assessment. Thus time for individual attention and assistance is also a contextual factor that impacts differently on the schools, influencing learner planning and enhancing volitional self-efficacy.

5.3.2.5.1.2 School T context versus context at schools K and S

The persistent reflective practice during questioning that dominated group discussions in school T may explain the medium effect difference in intention monitoring between schools T and K. When learners are given more opportunity to work by themselves in their groups, a sense of responsibility develops that promotes intention monitoring as they remind selves about what they are expected to do. Furthermore it was noted as evidenced through arguments and noise intensity, that the degree of interaction and communication of members in their groups at school T where learners were few in their groups differed from that at school K. In school K groups consisted of seven or more learners. Secondly it was noted that not all learners understood their roles in the groups and moreover it was difficult for them to remain focused to the end of lesson. Others were not sure of what was expected of them. The teacher communication was not clear while giving class direction and providing explanations. When questions were asked selective few members participated, pointing towards a likely different impact on learner intention monitoring. The continuous reflective practice during group discussions contributed to intention monitoring.

The medium effect difference between self-control pressure in schools T, S and K may be attributed to the effect of open group discussions where learners were used to finding out their way as teacher instructions at school T were notably unclear. However praising of groups by the teacher when members responded correctly to tasks compensated for unclear instruction and this created a healthy competitive mood in the class. Learners tried to follow through their mathematics tasks in anticipation of creating good self-impressions worthy of being praised in the presence of their peers for achieving better. This implies some difference on how learners exert self-control pressure to follow through their cognitive intentions in mathematics. Therefore group discussions and praise in class commit learners to self-control pressure.

5.3.2.5.1.3 School S context versus context at schools K and T

School S is a boarding school and christian orientated where learners are within a context that enforces christian principles of having faith in individual strength, honesty, fairness, self-control and self-discipline. This fact may be used to explain the difference in self-efficacy enhancement between schools S and K. The class and school atmosphere was calm, peaceful and welcoming, as the learners are enticed to make honest individual attempts during mathematics practice. The tranquil school environment lured learners to keep their concentration to the end of the mathematics lessons, unlike at schools K and T where even before the end of the lesson the noise would erupt from neighbouring classes interfering with learner concentration in mathematics class. In addition, daily and thorough individual homework check by the teacher at school S was followed by punitive measures against defaulters which reinforced self-discipline that enhanced self-efficacy.

5.3.2.5.2 Deduction about the relationship between learning context and volitional strategies in response to research question 2.2.

Are there any significant differences in the perceptions of sampled groups from the study population with regard to volitional strategy use in mathematics in grade 10 as determined by context?

As reported in the literature in chapter 3, the use of volitional strategy enhances effective learning and consequently the achievement of learners. The research verifies these findings as can be seen in table 5.12. Those learners who are at school R perceive the use of intention monitoring and emotion control most favourably while those at school K least favourably perceive the use of these strategies

In conclusion to section 5.3.2.5 there are contextual factors that seem to have a large effect difference on the way learners use their volitional strategies of attentional distractability, emotional perseverance rumination, self-efficacy enhancement and stress reducing actions. These contextual factors are detailed preparation and planning, use of illustrative diagrams, parental support, method of discipline, handling of errors, continuous assessment, opportunity to try, honesty, self-discipline and good communication skills. In compliance with literature as quoted in section 3.6.2 by Turner *et al.* (2003), Kuhl (2000) and McCann and Garcia (1999) these research results are in agreement.

In addition other contextual factors at these four schools seem to have a moderate effect difference on the way learners use their volitional strategies of emotional control, negative based incentives, volitional self-control, self-control pressure, planning, initiating introjection tendency, self-control pressure and self-efficacy enhancement. These contextual factors are namely a pleasant class mood, investigative group approach, use of praise, encouraging comments, individual attention, encouragement of voluntary activities, use of questions and persistent reflective practice. Also in section 3.6.2 literature as documented by Miranda (2002) and Tamsin (2002) is in accord.

Therefore, for the learners that participated in the empirical survey these results indicate learner perception that supports the existence of some relationship between learning context and volitional strategies used by learners in grade 10 mathematics classes.

5.3.2.6 Results: learner achievement in school contexts selected from different strata

5.3.2.6.1 Mathematics learner performance and / or achievement

Learner performance / achievement was measured using mathematics content tests. Table 5.13 indicates the raw mean scores for both tests in four schools. Test one was administered at the beginning of the year in order to have some idea of learner performance on entry from grade 9, that is the last year of middle school. Test two was administered in the third term to investigate the effect of teaching and the learning that occurred at the school in grade 10.

5.3.2.6.1.1 Comparison of mathematics learner performance between schools

Table 5.13 – Schools means standard deviation and root mean square

SCHOOL	T ₁		T ₂		Order (T ₂)
	Mean	Standard deviation	Mean	Standard deviation	
T	17,77	7,46	10,51	6,47	
R	31,41	11,34	18,49	10,53	Highest
S	18,07	11,21	6,47	5,21	
K	19,69	6,97	4,39	3,95	Lowest
√mse	9,40		6,57		

Reference is made to section 5.3.1.1 on firstly the means in order to compare learner performance between schools. From table 5.13 for T₁ the results of the four schools indicate a difference in learner performance that is significant. Thus on entry at their respective schools learner performance varied as indicated. The mean score for school R

is higher for T₁ while school K's mean score is the lowest amongst the four schools. The results for T₂ similarly indicate a difference between the schools that is of statistical significance in the same order of performance.

Table 5.14 - d – values and comparative effect size for T₁ and T₂

SCHOOLS	d- value T₁	d- value T₂	Effect size
T vs R	1,45	1.21**	Large
T vs S	0,03	0,6■	Medium
T vs K	0,20	0,9**	Large
R vs S	1,42	1,83**	Large
R vs K	1,25	2,14**	Large
S vs K	0,17	0,32	Small

In case of statistically significant differences the effect size, d, gives a measure of the practical significance for differences. The significance of differences between schools that is determined by making use of formula (1) for effect size, d is indicated in table 5.14.

With reference to section 5.3.1.1, the results indicate that there is a practically significant difference (**) between mathematics learner performance at School R in stratum 1 and the other three schools. There is also some large effect difference (**) between mathematics learner performance at schools T and K but both in stratum 2. Medium effect difference (■) between schools T and S in different strata is observed.

5.3.2.6.1.2 Deduction about the relationship between mathematics achievement and learning context in response to research question 2.1.

Are there any significant differences in the study population with regard to prevalent context in mathematics in grade 10 and learner performance?

The learning contexts at these schools differ as observed in section 5.3.2.5. Comparative school learner results on T_2 indicate a difference in learner performance between schools in the period between the time of writing T_1 and T_2 . Thus if other inborn factors are kept in constraint it is inferred that school context diversely influences learner performance. Hence results verify the finding in chapter 3.6.2 that cognitive strategy use is sensitive to contextual differences, as there seems to exist some relationship between context and performance. The attributive role of volitional strategy use in a prevailing learning context and study orientation was also presented as possible reasons for the difference in performance.

5.3.3 Conclusion about learner volitional strategy use, study orientation and learner performance in response to research question 1

How does the use of volitional strategies and learners' study orientation influence mathematics performance in grade 10?

With reference to sections 5.3.2.3 and 5.3.2.2, the learners at school R in stratum 1 out-performed learners at school S also in stratum 1 as well as learners in schools T and K in stratum 2. Similarly, learners at school T out-performed those at schools S and K. The difference in performance was attributed to some extent to the combined impact of their study orientation and volitional strategy use. Further detailed analysis was inferred in section 5.3.2.5 on learner volitional strategy use.

Therefore for those who participated in the research study learner perception about study orientation and about volitional strategies they believe they use, support the existence of a relationship between study orientation, and the use of volitional strategies and performance in grade 10 mathematics classes. This relationship in case of goal neglect, emotional perseverance inhibition and emotional perseverance rumination negatively correlated with performance (see tables 5.6 and 5.7).

5.4 CONCLUSION

In conclusion to this chapter the empirical part of the research was described and discussed. Some conclusions were made regarding school context, volitional strategies use impact on study orientation that in turn influenced learner performance, although the conclusions are with reference only to the schools where the research was done. It would be worth the while to extend this kind of research to find out what the status of volitional strategy use and study orientation in the rest of the country is.

In the next and concluding chapter the research is summarised, main conclusions are highlighted together with the constraints experienced while doing the research. Recommendations as well as suggestions for further research are made.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

In this chapter a brief summary of the research is given in order to establish if the aims of the study have been attained. The overall summary is made from both the theoretical and empirical perspective. The statement of the problem highlights the need to include volition, the key self-regulatory process that influences performance proficiency during mathematics teaching and learning. This is in view of poor grade 12 mathematics results in South Africa. The constructs of this study were organised to give prominence to contextual factors within which mathematics learning and teaching occurs. The literature review makes special reference to learning theories, study orientation, volition, skill acquisition, mathematics learner volitional strategies, learning context and learner performance. Main conclusion from both the literature and the empirical research are reported. The method and procedure of the research is provided. The results, conclusion and the constraints of the study are briefly highlighted. Some recommendations are made based on the outcomes of this study and further related research to this study is suggested.

6.2 STATEMENT OF THE PROBLEM

The need for an increased level of knowledge and skill proficiency in mathematics leaning is highlighted by poor matric mathematics results. In line with an attempt on transformation by the Department of Education there is a shift towards an outcomes-based school curriculum that emphasises the acquisition of knowledge and skill. However, skill acquisition is a dependable self-regulatory process determined by volition since, according to Ackerman (1989:660), the skill acquisition learning phase involves learners devoting their own attention to a particular task. And according to Corno,

(1993:15), skill acquisition depends on persistence that also is a volitional strategy (see paragraph 2.6).

If learner perceptions especially towards mathematics learning and teaching are examined, a better understanding could be obtained of the factors contributing to poor results. However, of worth to this study is the implication by Zimmerman and Risemberg (1997:110), that learner volition is a key self-regulatory process that influences performance proficiency, particularly in mathematics. Corno (1993:16) concurs that volition aids learning and performance. In this regard learner perceptions about the execution of self-regulatory and voluntary actions during mathematics learning were examined (see table 5.11).

Volition is often considered useful in enhancing persistence in learning (Dewitte & Lens, 1999). When contextual factors distract learners from goals to complete mathematical tasks, they need means to optimise motivational power and the intent to pursue goals. Volition strategies are such means. Employing a volitional strategy means to protect concentration and direct effort in the face of personal distractions (Kuhl & Beckman, 1985). The school context may hinder or support execution of such strategies and thus contribute towards how the learner orients himself to study (see paragraph 3.6.2.1). These strategies aid both learning and performance, in particular learners' study orientation in mathematics (Maree et al., 1997). Within the diagnosed framework this study made special reference to volitional strategies, study orientation and learning context. These were considered as possible causative variables (independent) that could inhibit or enhance performance and achievement. The dependent variable was performance in mathematics that was measured using mathematics content tests that were written during the normal teaching period.

This study analysed the construct volition, study orientation and context through investigating performance and achievement in grade 10 mathematics classes in some selected schools in Rustenburg. Thus the main aim of this research was to investigate the

relationship between learner volitional strategies, learning context, study orientation and the learning of mathematics in grade 10.

The aim of the study was broadly grounded on the investigation of the following research questions.

Research question 1

How does the use of volitional strategies and learners' study orientation influence mathematics performance in grade 10?

Research question 1.1

Are there any significant differences in the perceptions of sampled groups from the study population with regard to volitional strategy use in mathematics in grade 10 and study orientation?

Research question 1.2

Are there any significant differences in the perceptions of the sampled groups from the study population with regard to study orientation in mathematics in grade 10 as determined by learner performance?

Research question 1.3

Are there any significant differences in the perceptions of the sampled groups from the study population with regard to volitional strategy use in mathematics in grade 10 as determined by learner performance?

Research question 2

How does the learning context in grade 10 mathematics classes influence deployment of learner volitional strategies and ultimate learner performance?

Research question 2.1

Are there any significant differences in the study population with regard to prevalent context in mathematics in grade 10 and learner performance?

Research question 2.2

Are there any significant differences in the study population with regard to learner perceptions about study orientation and prevalent context in mathematics in grade 10?

Research question 2.3

Are there any significant differences in the perceptions of sampled groups in the study population in different learning contexts with regard to volitional strategy use in mathematics in grade 10?

Research question 3

Within the theoretical premises and the empirical results of this study, what recommendations emanating from volitional strategy use are proposed?

The aim of the research was to investigate the learning of mathematics as exhibited by learner performance in grade 10 classes, with particular attention to the use of volitional strategies, prevalent learning context and study orientation.

The objectives of this study were to:

- a) Analyse learner perceptions towards study orientation of the sampled groups and relate it to volitional strategies learners use in mathematics classrooms.
- b) Determine the relative influence of study orientation on the learning and achievement in mathematics of grade 10 learners.
- c) Evaluate learners' perceptions of their volitional strategy use with reference to their performance in mathematics of grade 10.
- d) Identify and analyse the contextual characteristics necessary for good performance in some "successful" grade 10 classes in learning of mathematics.
- e) Determine the relative influence of context on study orientation.
- f) Determine the relative influence of context on volitional strategy use.
- g) Make recommendations based on the findings of this study that will contribute towards suggesting suitable teaching-learning strategies to enhance mathematics learners' volitional strategies and ultimately their improved performance.

6.3 AN OVERVIEW OF THE LITERATURE STUDY IN RELATION TO THE EMPIRICAL FINDINGS

These steps were carried out in order to achieve the aim that was set for this study to investigate the learning in mathematics as exhibited by learner performance in grade 10 classes, with particular attention to the use of volitional strategies, prevalent learning context and study orientation. The researcher firstly tried to scrutinise in chapter 2 how teachers conceived mathematics learning views influenced mathematics teaching and learning. Even values and beliefs on study orientation were scrutinised. Also in same chapter 2 the need for teachers to take cognisance of the construct volition in promoting

affect, the use of learning strategies, self-regulation and self-control in goal as well as self-maintenance were discussed. The influences that school mathematics context have or could possibly have on learner use of volitional strategies were indicated in chapter 3. The first aim of the study was thus partially attained.

The secondary aim was to make some analysis of the characteristics of study orientation fields and to determine particular volitional strategy learners employ in mathematics classroom context. This was also done in chapter 2 and 3 respectively. The relative influence of volitional strategies on study orientation and ultimate achievement in mathematics of grade 10 learners were discussed. In chapter 3 the nature of mathematics context demands that promote study orientation were examined.

In the following paragraphs the main conclusions of the literature study are highlighted with some comparisons made to the empirical findings.

Volitional strategies

Volition is a construct that aids learning and performance as it plays a role in effort direction in the face of personal and environmental distractions (Corno, 1993:16). Garcia, *et al.* (1998:393) posit volition as those thoughts and / or behaviours that are directed towards maintaining one's attention to attain a specific goal in the face of both internal and external distractions. Volitional strategies as control processes are involved in making sure that a goal (mathematics objective) is pursued or accomplished (Oettingen *et al.*, 2000). The Pearson's correlation coefficient reflects some negative effects of goal neglect that could be of practical significance to the performance of learners at one school in stratum 2 ($r = 0,39$)(see paragraph 5.3.2.3), while for a school in stratum 1 same correlation coefficient implies possible practical significance of effort direction as measured by scales of shiftcost action ($r = 0,43$), shiftcosts cognitive aspect ($r = 0,37$) towards learner performance (outlined on the scales in paragraph 4.4.3.4). Even perceptions about effort exerted during failure control also reflected practical significant effect difference on learner performance ($r = 0,49$) as indicated in table 5.7.

Garcia *et al.* (1998:399) attest that volitional strategies promote implementation and completion of intentions (see paragraph 2.5.2). From results of the empirical study in relation to research question 2.3, the difference in group responses towards attentional distractability was of practical significance, while some moderate effect difference was observed for intention monitoring, planning and self-control (see paragraph 5.3.2.5). This is in agreement with literature, as documented by Corno (1993:16); and McCann and Garcia (1999:260) that suggest mobilisation and maintenance of one's attention and effort toward goal attainment are necessary pre-requisites to positive learning outcomes.

From the empirical study the Pearson's correlation coefficient reflects some negative correlation of practical significance for emotional perseverance inhibition on performance for school R in stratum 1 ($r = -0.52$) (see table 5.7). This and the above indicate negative correlation for failure control, and are in line with results by Kuhl and Kraska (1989) that demonstrate a negative correlation between emotion control and fear of failure. However De Witte and Lens (1999: 327) indicated that emotional regulation could be positively related to performance for test-anxious learners. Turner *et al.* (1998:761) postulated that emotion is crucial in directing the patterns of cognition, motivation and self-regulation. In this survey learners whose results are used in comparative analysis achieved higher marks in mathematics and were at a school R in stratum 1. With reference to the difference in learner deployment of volitional resources in response to research question 2.3, the VCI mean scores for emotion control (frequency = 37.19) and emotional perseverance rumination (frequency = 42.35) are higher for school R in stratum 1. Likewise the effect size difference for the usage of two named strategies demonstrates a practical significant difference between school R and other schools in strata 1 and 2 (see table 5.11). According to Turner *et al.* (1998:758), negative affect after failure mediates positive performance goals and self-regulatory beliefs and behaviour.

Learning context

Conclusive remarks on learning context are made on the basis of lesson observations at the schools involved. At school R there was evidence of well-planned lessons by the teacher during observation days. Learner participation and lesson flow are detailed in paragraph 5.2.2. Learner performance at this school was the highest on both written tests (see table 5.13). The second best performing school on the written tests was school T. At this school co-operative learning was practised, no evidence of teacher planning was produced. Details of how lessons observed flowed are included in paragraph 5.2.1. The effect size differences on test performance show considerable significant differences between school T and the other three. Likewise there is large effect difference in performance between schools T and K (see table 5.14). Wolters and Pintrich (1998) indicate that motivational aspects of self-regulated learning are context specific and the level of cognitive strategy use is sensitive to contextual differences. Bottge (2001) also indicates that during directive instruction the teachers' work that is well structured, specifying important tasks with carefully constructed explicit instruction can dramatically improve computational skills of learners with disabilities. According to an observation report at school R the teacher's work was well structured. Moreover Maree *et al.* (1997:9) ascribe non-stimulating learning and study environments and non-understanding of specific language of mathematics to mathematics anxiety that undermines pupils' self-confidence and inhibits mathematics achievement. Cummins (1996) puts forward that children who learn through a second language would not achieve the same outcomes as those learning through their first language. Therefore first language could be another added factor in the context at school R that contributes to performance.

The social context of the teaching situations, particularly the constraints and opportunities it provides, influences the practice of mathematics teaching (Thompson, 1992:131).

Study orientation

According to Maree *et al.* (1997: 3) there is statistically significant association between aspects of study orientation in mathematics and achievement. From the empirical study the Pearson's correlation coefficient (see table 5.4) reflects some correlation of practical significance for attitude on performance for school R in stratum 1 ($r = 0,36$) and school K ($r = 0,32$) (see table 5.5). Similarly there is a moderate effect of information processing on performance for school R ($r = 0,35$). This is in agreement with Du Toit, (1970) findings about study habits and attitudes having a predictive value with respect to academic achievement. Galagedera *et al.* (2000:681) reports significant correlation between attitudes towards mathematics and mathematics scores in a study of standard 10 students in South Africa.

The results indicate the presence of a significant difference in study orientation between schools R and T as well as schools T and S that was displayed in learner perceptions on the study milieu aspect of study orientation as shown in table 5.10. In addition, there is evidence of a moderate effect difference between schools T and S in attitude, anxiety, study habits and information processing aspects of study orientation. According to Maree *et al.* (1997:9), the second language problem, which is restrictive and milieu deprived, often leads to mathematics anxiety, undermines learner self-confidence and inhibits mathematics achievement. Drodge and Reid (2000:249) stress the significance of emotional orientation impacting on learning mastery during mathematical activities.

Learning of mathematics

The study reflects significant differences of learner performance in school contexts as observed in different strata (see table 5.13 and 5.14). According to the problem solving view, mathematics learning is a goal striving process of inquiry, coming to know and adding to the sum of existing knowledge (Thompson, 1992:132). This is dynamic as cognitive thought actions are influenced in types of social contexts by unstable affective factors like pride, mood, motivation and volition. According to Husman *et al.*, (2001),

goal striving is a dynamic process where individuals encounter distractions or frustrations that 'derail' an initial motivational intent to accomplish a particular goal. But knowledge is derived from interactions between persons and their context, as these reflect the outcomes of mental contradictions as a result of these interactions (Von Glasersfeld, 1995).

6.4 RESULTS OF THE EMPIRICAL STUDY

The objectives of this study (see paragraph 1.3)

6.4.1 Research Question 1

How does the use of volitional strategies and learners' study orientation influence mathematics performance in grade 10?

In tables 5.4 and 5.5 direct influence of attitude and information processing on performance was observed at school R. In tables 5.6 and 5.7 the existence of negative correlation between goal neglect, emotional perseverance rumination and emotional perseverance inhibition and test performance at schools T and R was observed. As schools T and R had higher test scores (see table 5.13), it can be inferred that positive study orientation and volitional strategy use increased their attributive effect on performance.

6.4.2 Research Question 1.1

Are there any significant differences in the perceptions of two sampled groups in the study population with regard to volitional strategy use in mathematics in grade 10 and study orientation?

There is large effect correlation between VCI and SOM results (see table 5.3). The correlation reaffirms a strong significant link between learner perceptions with regard to use of volitional strategies and study orientation.

6.4.3 Research Question 1.2

Are there any significant differences in the perceptions of the two sampled groups in the study population with regard to study orientation in mathematics in grade 10 as determined by learner performance?

The research study reveals that in schools R and K there is a moderate influence of attitudes on their mathematics performance. Furthermore, for school R as reflected by learner perceptions, the way learners believe they process information has a significant effect on their performance (see tables 5.4 and 5.5). Therefore an association between aspects of study orientation and mathematics performance exists since both attitudes and information processing are some of the fields of study orientation.

6.4.4 Research Question 1.3

Are there any significant differences in the perceptions of the two sampled groups in the study population with regard to volitional strategy use in mathematics in grade 10 as determined by learner performance?

The results for learners at school R suggest a strong negative correlation of emotional perseverance inhibition and emotional perseverance rumination but a strong positive correlation between failure control and performance (see table 5.6 and 5.7). At school R there is also a moderate effect of shiftcost action and shiftcosts cognitive aspect on performance. Therefore use of volitional strategy has a moderate to strong effect on performance.

6.4.5 Research Question 2

How does the learning context in grade 10 mathematics classes influence deployment of learner volitional strategies and ultimate learner performance?

According to table 5.12, volitional strategies are diversely used in different types of school context. These strategies of self-efficacy enhancement, emotion control and attentional distractability are differentially used between schools R and T or S or K. The context at school R was comparatively more conducive to direct instructional learning (see 5.2.2). As school R achieved highest among the four, it can be deduced that context induced volitional strategy impacted on learner achievement.

6.4.6 Research Question 2.1

Are there any significant differences in the study population with regard to prevalent context in mathematics in grade 10 and learner performance?

These results indicate that school R learner performance is significantly different from that at S, T and K (see table 5.13). Even school T learner performance is significantly different from that of school K. Therefore, for these learners who participated, context influences learner performance.

6.4.7 Research Question 2.2

Are there any significant differences in the study population with regard to prevalent context in mathematics in grade 10 and study orientation?

In table 5.10 there is significant difference between study milieu and learning context for learners at schools R and T. Similarly, between learners at schools T and S there is a significant difference. There is also evidence of a moderate impact difference between schools R and S, R and T, R and K respectively of study milieu, attitudes, information

processing, anxiety and study habits. Likewise there is a moderate impact difference between schools T and S in attitudes, anxiety, study-habits and information processing and school context. Thus the school learning context moderately to strongly affects aspects of study orientation.

6.4.8 Research Question 2.3

Are there any significant differences in the perceptions of the two sampled groups in the study population in different learning contexts with regard to volitional strategy use in mathematics in grade 10?

The research findings as shown in table 5.10 indicate that those learners who are at school R more favourably perceive the use of attentional distractability, emotion control, emotional perseverance rumination and stress reducing than those at schools T, S and K. For the same learners at school R there is evidence of a differential effect of self-efficacy enhancement, volitional self- efficacy, self-control pressure, planning, initiating and introjection tendency, more so than those at T, S and K. Therefore, for the learners that participated in the empirical survey these results indicate learner perception that supports the existence of some relationship between learning context and volitional strategies as used by these learners in grade 10 mathematics classes.

6.4.9 Research Question 3

Within the theoretical premises and the empirical results of this study, what recommendations emanating from volitional strategy use are proposed?

Research on volition focuses on the nature of self-determination and effortful behaviour during goal striving situations (see. paragraph 2.5.5 & 3.4.1). The evaluation of volitional strategy use was assessed against performance and achievement of learners in the teaching and learning of mathematics at some schools. In the light of results as

reflected in tables 5.11 and 5.12 indicating differential use of these strategies in schools their inclusion is recommended in the current and future school curriculum. Details of recommendations are included in paragraph 6.8.

6.5 LIMITATIONS OF THE STUDY

The results of this research conducted at specific schools in the district are limited by being interpreted as a generalised evaluation of volitional strategy use at national level by the following factors:

6.5.1 Sample size

The study population that participated in this research may not have been representative of the constituency for teaching and learning in South Africa. A convenient sample was selected. Only four teachers and learners ($n = 390$) in their respective classes were involved; there was no random sampling applied.

6.5.2 Instrumentation

The VCI questionnaire (see paragraph 4.4.3.4) was adapted and modified (for use at school level) from Kuhl and Fuhrmann (1998) who first developed it. The AVSI questionnaire (see paragraph 4.4.3.3) was adapted and modified from McCann and Garcia (1999) who first developed the questionnaire. The survey instrument describes frequency of occurrence without explaining its origins or the underlying processes that prompt the behaviour. The other variables that may affect learner response are understanding and precise interpretation in English of what the questionnaire measures, accurate reflection of interpretation by individual learner, the degree of honesty in the response and the learner aptitude.

The extent to which both mathematics tests were accommodated in the overall learner schedule and accompanying expectations arising thereof were also constraints.

6.5.3 Specific study

The other limitation is that the study was specific as only participants from Rustenburg district were involved due to constraints both in time and financial resources.

6.6 SIGNIFICANCE OF THE STUDY

This study highlights the need for creation of mathematics learning context that will induce learner use of volitional strategies as well as the significant role of study orientation in determining learner performance.

6.7 RECOMMENDATIONS

The findings of the present study that investigated learner volitional strategy use, learning context, study orientation and the learning of mathematics, support the importance of volition in teaching and learning. In view of persistent poor matric mathematics results in South Africa these findings register as alternative incorporation of volitional control during curriculum transformation to facilitate performance in mathematics.

The following recommendations based on the result findings are further proposed:

Studies involving dynamic variance in volitional strategy use and learner achievement in mathematics with pre- and post testing.

This research should be extended to include more teachers and learners (primary school learners as well) and other subjects.

To facilitate performance in mathematics, content area instruction, cognitive strategy instruction and integration of affective factors (volition, emotion and beliefs) are recommended.

Comparative studies should be done in other provinces to try and find workable solutions for the problems concerning mathematics teaching and learning.

6.8 CONCLUSION

In this research learning of mathematics in grade 10 as reflected by learner performance was investigated with particular reference to learner volitional strategies use, learning context and study orientation in mathematics. The results indicate that for a school in stratum 1 (school R) with learner performance significantly different from those at S, T and K, there was an association between aspects of study orientation (attitudes and information processing) and mathematics performance. There was a strong significant link between learner perceptions with regard to the use of volitional strategies and study orientation. With reference to higher test scores at schools T and R an inference that positive study orientation and volitional strategy use increased their attributive effect on performance was made. Furthermore, for school R, a strong negative correlation of emotional perseverance inhibition and emotional perseverance rumination and a strong positive correlation between failure control and performance were observed, hence the deduction that use of volitional strategy has a moderate to strong effect on performance.

A significant difference between study milieu and learning context for learners at schools R and T was also detected. In addition, moderate impact difference was noticed between schools T and S in attitude, anxiety, study-habits and information processing. Thus school learning context moderately to strongly affects aspects of study orientation. Learners at school R more favourably perceived the use of attentional distractability, emotion control, emotional perseverance rumination and stress reducing than those at schools T, S and K. So volitional strategies were diversely used in different types of school context therefore the deduction that mathematics learning context involve volitional strategy use that impact on learner achievement.

The researcher is therefore persuaded that through training in appropriate knowledge, skills and the use of volitional strategies teachers will be able to create a more favourable leaning context in their classes that will enhance study orientation in general, and particularly in mathematics.

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APPENDIX – A

GRADE 10

MATHEMATICS TEST

1. This test forms part of a research project.
2. The results of the test will not contribute to your normal school assessment.
3. Your participation is however appreciated.

INSTRUCTION TO LEARNERS

- 1 Please write neatly in a manner easy to read.
- 2 Answer ALL questions
- 3 Section A – four alternative answers are given you are to choose the correct answer and cross out the corresponding letter on the question paper.
- 4 Section B – show ALL the necessary working on the space provided

Compiled by: D. L.Molokoli.

Phone: 082 660 6288 (Cell)

014 592 1524 (H)

Moderator: 1. Myburg

2 Father Fank

3 Makinita M I

4 Mabhena

Name of the school: _____

Name of learner: _____

Sex: _____

Age: _____

Time: 1½ Hours

Marks: 100

Section A

Choose the correct answer from the given alternative answers and mark the corresponding letter on the question paper.

1. $(a - b)^2 =$
A. $a^2 - 2ab - b^2$ B. $a^2 - 2ab + b^2$ C. $a^2 + b^2$ D. $a^2 - b^2$
2. The gradient m of the line $3y - x = -6$ is
A. -1 B. -2 C. 3 D. $\frac{1}{2}$
3. $x^2 - 8x + 15 =$
A. $(x - 5)(x - 3)$ B. $(x + 5)(x - 3)$ C. $(x - 5)(x + 3)$ D. $(x + 5)(x + 3)$
4. If $\frac{a}{7} = 4$ then $a =$
A. 42 B. 25 C. 14 D. $\frac{5}{7}$
5. Which of the following points lie on the line $2x + y = 4$
A. (-1; 5) B. (1; -6) C. (1; -2) D. ($\frac{1}{2}$; -3)

6. $2^2 + 3^0 =$

A 7

B 3

C $1\frac{3}{4}$

D 1

7. Two angles are complementary if they add up to

A 45^0

B 90^0

C 180^0

D 360^0

8. When two straight lines are cut by a transversal so that any corresponding lines are equal then the lines are

A equal

B parallel

C perpendicular

D otherwise

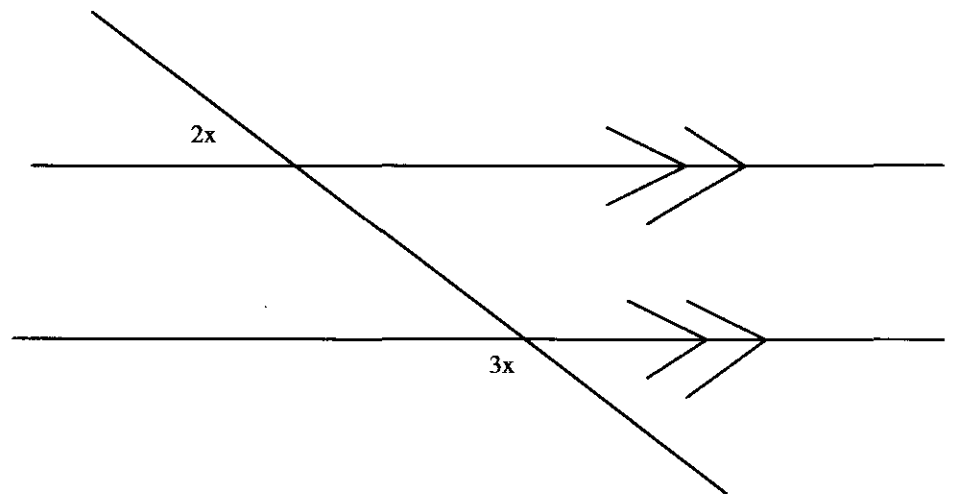
9. The value of x

A 18^0

B 36^0

C 60^0

D 30^0



10. In $\triangle ABC$, $\angle B = \angle C$ and $\angle A = 50^0$ then $\angle B =$

A 40^0

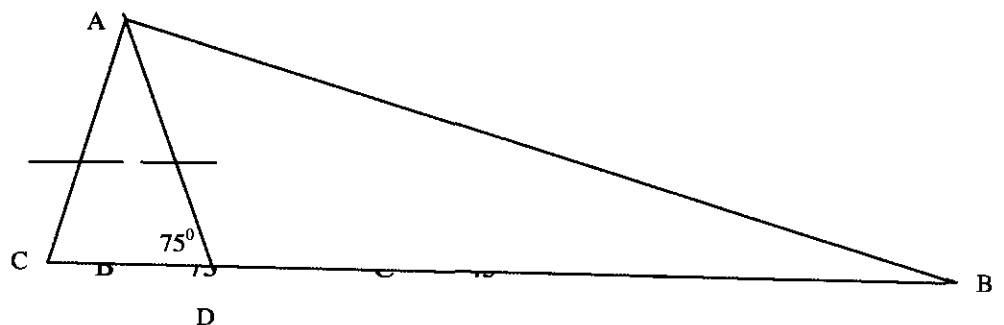
B 50^0

C 60^0

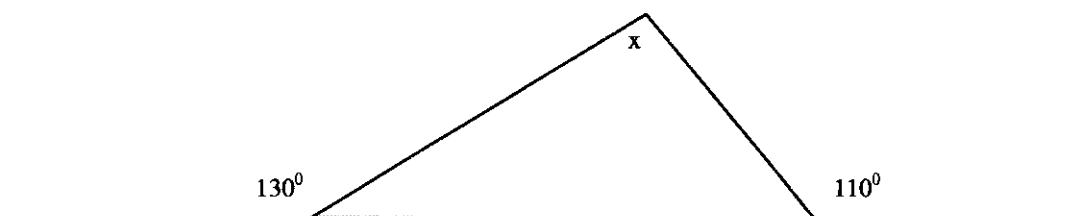
D 65^0

11. Given $\angle BAC = 90^0$ and $AD = AC$, then $\angle BAD =$

A 30^0



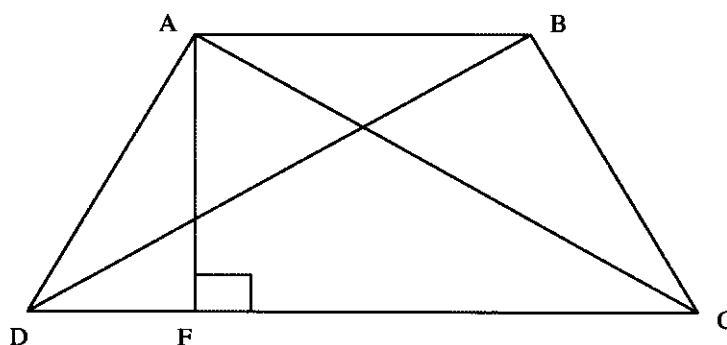
- 12 The size of x is



- A 30° B 40° C 50° D 60°

- 13 The area of the figure ABCD

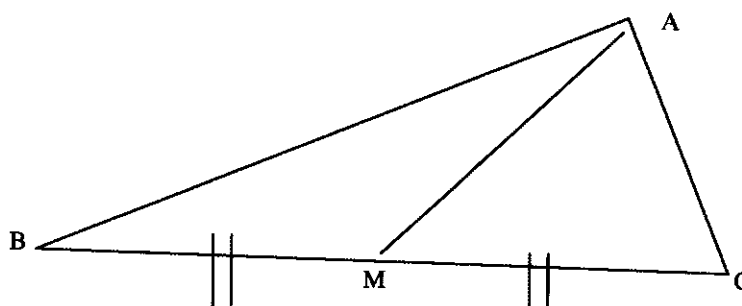
- A $AF \cdot DC$
 B $\frac{1}{2} DC(AD + BC)$
 C $AC \cdot DB$
 D $\frac{1}{2} AF(AB + DC)$



- 14 The diagonals of ----- are equal
 A rhombus B rectangle C parallelogram D trapezium

- 15 In the diagram AM is

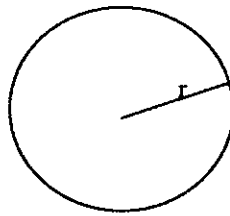
- A altitude
 B median
 C bisector
 D perpendicular bisector



- 16 The number of lines of symmetry in an isosceles triangle

- A 1 B 2 C 3 D 4

- 17 An acute angle lies between
 A 0° and 90° B 90° and 180° C 180° and 270° D 270° and 360°
- 18 The supplement of angle 75° is
 A 25° B 15° C 105° D 125°
- 19 Any two triangles with two pairs of angles equal are
 A congruent B similar C perpendicular D euilateral
- 20 The area of a circle is given by
 A πr^2
 B $2\pi r$
 C π^2
 D $2\pi^2 r$



Section B

Answer on the space provided

2 Simplify

2.1.1 $2^3 + (x + y)^2 + \frac{2^3 \cdot 2^4}{2^2}$

.....

(4)

2.1.2 $(2x - 3)(4x^2 - 5x + 1)$

.....

(4)

2.2 If $a = -3$, $b = -1$ and $c = 2$. Calculate the value of $\frac{3a}{b-c}$

.....

.....(3)

2.3 Factorise $(x^2 - x) - (2 - 2x)$

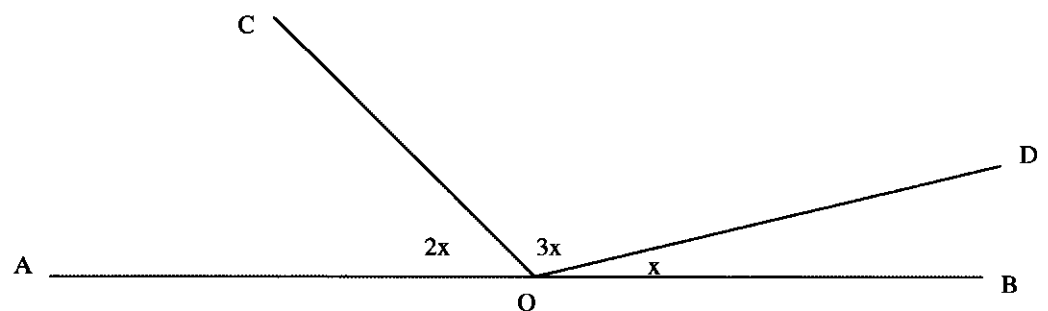
.....(3)

3.1 Complete

The sum of adjacent angles on a straight line is

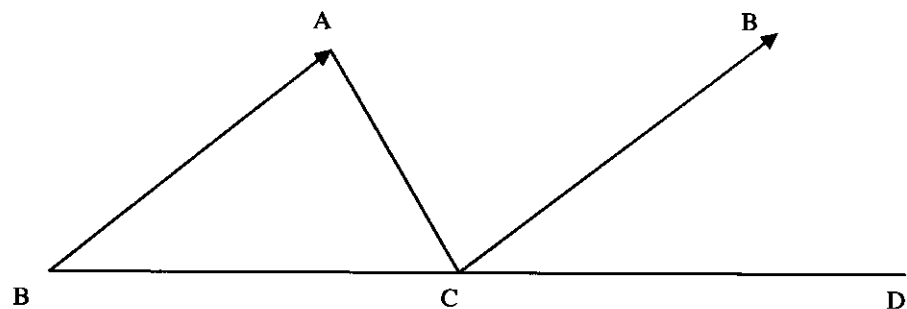
.....(1)

3.2 Calculate x and angle COD. Give reasons



.....(5)

4 Prove the theorem: The exterior angle of a triangle is equal to the sum of the opposite interior angles



.....
.....
.....
.....
.....
.....
.....(5)

5.1 Complete:

The vertical angle of an isosceles triangle is x , each base angle is thus equal to

.....
.....
.....(2)

APPENDIX B

MATHEMATICS TEST (T₂)

GRADE 10

NAME OF LEARNER: [HG / SG]

Age; Sex :

NAME OF SCHOOL: Examiner : *Molokoli D L*
Moderator : *Myburgh E C*

Kindly note that your participation in taking this test is highly appreciated. The marks obtained will however not contribute to your continuous assessment.

FOR EACH OF QUESTIONS 1 TO 5 YOU ARE TO CHOOSE THE CORRECT ANSWER AND MARK A CROSS AGAINST THE CORRESPONDING LETTER ON THE ANSWER SHEET.

1. $(x - 2)$ and $(x + 4)$ are correct factors of
A $x^2 - 2x - 8$ B $x^2 + 2x - 8$ C $x^2 - 4x + 8$ D $x^2 + 4x + 8$
2. If $(x + 4y)(x^2 \dots\dots + 16y^2) = (x^3 + 64y^3)$. The term left out is
A $+ 2xy$ B $- 2xy$ C $+ 4xy$ D $- 4xy$
3. The factors of $P^2 + p - pq^2 - q$ are
A $(p - q)(p + 1)$ C $(p + q)(p + 1)$
B $(p - q)(p - 1)$ D $(p + q)(p - 1)$
4. When a transversal line cuts across two parallel, the co – interior angles lines are
A complimentary B perpendicular C Supplementary D Equal
5. If $2x + 14 = 5 - x$, then the value of x that makes the statement true is
A 3 B -3 C -9 D 6

$$[5 \times 3 = 15]$$

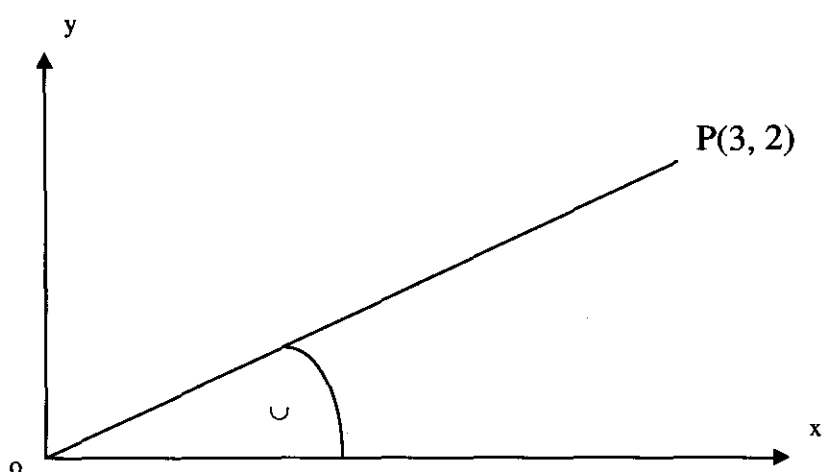
FOR QUESTIONS 6 TO 12 SHOW YOUR WORKING IN THE SPACE PROVIDED ON THE ANSWER SHEET

6. Factorize completely $(a^3 - 27b^3)$ { HG only} (5)

7.1 Solve $x^2 - 5x = 0$ (3)

7.2 $3x^2 - 2x - 8 = 0$ (5)

8. For which values of x is $\frac{x-1}{2x^2-8}$ undefined? (3)

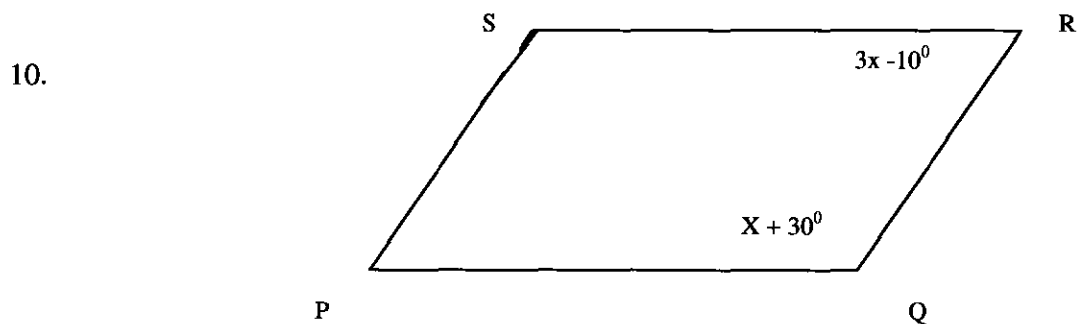


9. Given $P(x, y)$ on co-ordinate diagram, line OP drawn makes an angle θ with the line x -axis. The co-ordinates of P are $(3; 2)$.

9.1. Prove that $OP = \sqrt{13}$ (3)

9.2.1 Calculate the value of $\tan \theta$ (2)

9.2.2. Calculate the value of $2\sin^2 \theta$ (3)



PQRS is a parallelogram $\angle R = 3x - 10^\circ$ and $\angle Q = x + 30^\circ$. Find:

10.1 the value x (3)

10.2 the size of $\angle P$ and $\angle S$ (4)

11. Mention four conditions necessary for two triangles to be congruent. (4)

12. Two boxes contain a total of 144 sweets. If 21 sweets are moved from the first box to the second box, the second box will contain twice as many sweets as first box. Find the original number of sweets in each box. (10)

HG - [60]

SG - [55]

APPENDIX -C

VCI [1]

There are quite different ways to handle mathematical goals either set by yourself or set by others. Sometimes you are willing to put forth a lot of effort and in other situations you prefer to let things run their course. Or you are slow to take on an unpleasant or difficult mathematical activity or you may even refuse it.

Julius Kuhl and

Arno Fuhrmann first developed this VCI in 1998. It has been adapted for Mathematics by Molokoli D and Dr.Nieuwoudt H D in 2003

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	Sometimes	somewhat often	often	almost always

How do I feel about doing something difficult or unpleasant in mathematics?		This is how often I am like that:								
[001]	Preferring to do things that can be done without much effort.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
2	Struggling against the expectations others have of me.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
3	Simply forcing myself to do something.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
4	Plunging into something and then seeing how it goes.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
5	Avoiding difficult goals.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
6	Preferring to risk an argument than to give in to another's wishes.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
7	Pulling myself together.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
8	Preferring to follow my spontaneous ideas even on difficult projects.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
9	Feeling better when something is easy to accomplish.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
10	Refusing to satisfy others' demands.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
11	Imposing discipline on myself.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
12	Relying more on my intuitions than on complex plans made in advance.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
13	Preferring to do things that are easy to do.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
14	Becoming angry when others' rules restrict my freedom.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
15	Putting pressure on myself.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
16	Throwing myself into something without lengthy preparation and trying to make the best of it.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[017]	When possible, staying away from uncomfortable demands.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

How do I feel about doing something difficult or unpleasant in mathematics?		This is how often I am like that:								
[018]	Simply ignoring others' demands.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
19	Telling myself "You have to..."	almost never	①	②	③	④	⑤	⑥	⑦	almost always
20	Initiating action without having planned the matter from A to Z.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
21	Reluctantly forcing myself to do something difficult.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
22	Defying orders from others.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
23	Treating myself harshly.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
24	Spontaneously trying something out rather than thinking about it for a long time.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
25	Readily putting difficult things aside.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
26	Avoiding being forced to meet other's expectations.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
27	Disciplining myself.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[028]	Doing things where I can simply act according to my inspirations of the moment.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

There are situations when it is difficult to choose one of several goals. Even after making a choice, doubts may arise as to whether the decision was correct. Once a decision has been made, it is important that certain things actually get done. Then the question of when the best place or time to complete the tasks may arise because difficult or unpleasant things cannot always be handled on the spot. Therefore it is important to remember at the appropriate time which tasks were to be completed at that time, which one doesn't always succeed in doing.

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

What is my experience when I have to make a decision or stay aware of my mathematics projects?		This is how often I am like that:								
[029]	Being able to arrive at a decision quickly, if necessary.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
30	Being able to make a decision without too much contemplation.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
31	Sensing clearly whether my decision is correct.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
32	Being able to stop pondering alternatives when a quick decision is needed.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
33	Making a quick decision.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
34	Being able to arrive at a decision quickly when time is short.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
35	Repeatedly reminding myself during the day of all the things I want to do.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
36	Using alarm-clocks and other technical aids to remind me of important things I intend to do.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
37	Being afraid of forgetting what I intended to do.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
38	Using a "string tied to my finger" and similar tricks to prevent forgetting.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
39	Forgetting to do some of the things I intended to do, even though I thought of them repeatedly.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
40	Carrying things with me to remind me of something I intend to do.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
41	Telling myself all the things I want to do.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
42	Feeling clearly that a decision is correct once I've arrived at it.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[043]	Using an appointment book or notepad to keep my mind free for other things.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

What is my experience when I have to make a decision or stay aware of my mathematics projects?		This is how often I am like that:								
[044]	Being uncertain whether I will remember to do what I had intended to at the right time.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
45	Seeing to it that I "stumble across" reminders of my intentions by putting appropriate notices in places where I will see them.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
46	During the day, repeatedly reminding myself of an important project.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
47	Writing down important yet unpleasant intended actions if they cannot be tackled immediately.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
48	Being completely certain of my decision after making it.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
49	Repeatedly reminding myself of my plans and intentions.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
50	Using memory aids to ease the burden on my mind.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
51	Bringing to mind again and again what I have to do.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[052]	Finding useful memory aids to better remember my intentions.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

Perhaps you remembered some intention of yours in time and have already planned how you will proceed. In spite of that it may be difficult to actually start what you had planned to do (e.g., participating in more sports, , preparing for a mathematics exam, cleaning up the basement, etc.). Sometimes you are successful in starting without difficulty, and sometimes you simply cannot get going and perhaps only do so under time pressure.

①	②	③	④	⑤	⑥	⑦
Almost never	seldom	somewhat seldom	sometimes	somewhat often	Often	almost always

What's my experience with starting and staying with a mathematics activity that I didn't like taking on?		This is how often I am like that:								
[053]	Feeling as if I have to force myself to get going.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
54	Considering how to proceed.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
55	Digging in right away.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
56	Waiting until others get impatient.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
57	Planning something and not following through.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
58	Feeling too defeated to get started right away.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
59	Explain the necessary steps to myself.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
60	Starting without hesitation.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
61	Getting going only when time becomes short.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
62	Starting something and quickly letting it drop.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
63	Feeling too listless to even get started on something.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
64	Going over the details of a matter in my mind.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
65	Starting immediately even with unpleasant activities.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
66	Getting going only after somebody gets angry.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[067]	Telling myself: You can always do it tomorrow.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

What's my experience with starting and staying with a mathematics activity that I didn't like taking on?	This is how often I am like that:
--	-----------------------------------

[068] Feeling zestless.	almost never	①	②	③	④	⑤	⑥	⑦	Almost always
69. Making a plan for the best way to start mathematics activity.	almost never	①	②	③	④	⑤	⑥	⑦	Almost always
70. Starting vigorously at the first good opportunity.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
71. Taking care of unpleasant things only at the last minute.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
72. Dropping mathematics activity after an enthusiastic start.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
73. Taking a lot of energy to finally get started.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
74. Making up a schedule.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
75. Starting with vigor.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
76. Getting going only after someone puts me under pressure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
77. Repeatedly postponing mathematical activity.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
78. Feeling too much lack of drive to simply get going.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
79. Determining how I want to proceed.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
80. Starting work on difficult matters immediately.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
81. Waiting until the last minute to get started.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
82. Getting started on one thing and then doing something else.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
83. Lacking energy.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
84. Making a plan for myself.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
85. Getting going immediately.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
86. Getting going more easily if somebody else joins in.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[087] Somehow forgetting about a planned project.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

Sometimes it is easy to fully concentrate on difficult or unpleasant matters. But often it is difficult to keep your attention on them because you are too excited or too nervous or because your thoughts wander. Therefore, you end up neglecting difficult or unpleasant things...

VCI [4]

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

What's my experience when I want to concentrate completely on something?		This is how often I am like that:								
[088]	Deliberately focusing only on the essentials.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
89.	Getting into my best form only when facing a challenge.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
90.	Instinctively keeping the goal in mind.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
91.	All of a sudden thinking of something else.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
92.	Being able to relax quickly even after some inner tension.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
93.	Deliberately paying attention to anything that is important for the matter at hand.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
94.	Feeling most lively when circumstances challenge me.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
95.	Automatically paying attention only to those things that will bring me closer to my goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
96.	Suddenly finding myself thinking about something completely different.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
97.	Getting rid of nervousness quickly.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
98.	Starting an activity with full concentration.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
99.	Being particularly wide awake in difficult situations.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
100.	Staying focused on the business at hand without any effort.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
101.	My mind wandering.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
102.	Being able to handle my excitement before it becomes a hindrance.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
103.	Picking out only the essentials to focus on.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[104]	Being really alert only after a difficulty arises.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

What's my experience when I want to concentrate completely on something?	This is how often I am like that:
---	--

105] Instinctively paying attention to anything that is important for reaching my goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
106. Having a hard time concentrating.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
107. Becoming quite calm when being excited would hinder me.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
108. Concentrating only on whatever is important at the moment.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
109. Really hitting my stride when obstacles arise.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
110. Being able to concentrate even on a difficult task without any effort.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
111. Finding myself daydreaming despite wanting to concentrate on something.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
112. Being able to deliberately get rid of my nervousness.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
113. Deliberately increasing my concentration.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
114. Being spurred to my top form by difficulties in attaining a goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
115. Being absorbed in something without losing sight of my actual goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
116. Repeatedly thinking of things that are different than my goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
117. Being able to reduce my tension if it threatens to get in my way.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
118. Keeping my mind on my goals.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
119. Feeling energized as soon as I face obstacles.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
120. Finding my attention drawn to what I am doing.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
121. Drifting away from what I am doing without intending to do so.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
122. Being able to deliberately reduce my nervousness.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
123. Getting really motivated by difficulties when I am trying to accomplish something.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
124] Being able to reduce my level of excitement when it is disruptive.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

While you are occupied with a difficult or unpleasant matter, different things may cross your mind. Sometimes these thoughts and sensations are positively toned (e.g., hopeful, optimistic); on other occasions they may instead be negative (e.g., doubts, apprehensions)...

VCI [5]

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

What crosses my mind when I pursue a challenging goal?		This is how often I am like that:								
[125]	Sensing that I am doing something of my own free will.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
126.	Thinking that I have what it takes.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
127.	Experiencing an intense and pleasant feeling of taking action.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
128.	Feeling that I am gradually getting a handle on something difficult through my own abilities.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
129.	Being afraid of losing others' good will if I don't come through on a project.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
130.	Being certain that it will all come out all right.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
131.	Taking action in the knowledge that I am acting on my own free will.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
132.	Being convinced that I have the necessary determination to succeed.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
133.	Enjoying a feeling of competence while doing something difficult.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
134.	Feeling obliged to fulfill someone else's expectations.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
135.	Assuming that it will somehow work out all right.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
136.	Being in harmony with myself.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
137.	Being convinced that I will stick it out in spite of all the difficulties.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
138.	Feeling as if I am in control despite obstacles.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
139.	Being guided by what others expect of me.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
140.	Being confident that I'll think of something that will work.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[141]	Knowing that I really want to reach a particular goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

What crosses my mind when I pursue a challenging goal?		This is how often I am like that:								
[142]	Having faith in my endurance.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
143.	Having a sense of being able to handle a challenging task	almost never	①	②	③	④	⑤	⑥	⑦	almost always
144.	Feeling that I am dependent on others.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
145.	Feeling self-confident.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
146.	Sensing that it is I who want to pursue a particular goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
147.	Feeling certain that my will-power is strong enough.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
148.	Feeling self-sufficient even during a demanding activity.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
149.	Imagining what others would think if I don't do a certain thing.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
150.	Facing things with a positive attitude.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
151.	Feeling free.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
152.	Knowing that I won't give up on it.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
153.	Maintaining a good feeling of competence even when the going gets tough.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
154.	Acting as if I want to please others.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
155.	Feeling confident that I will cope one way or another.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
156.	Knowing that I really want something.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
157.	Having the commitment to see something through to its end.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
158.	Having a reassuring sense of approaching a hard goal step by step.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
159.	Just enjoying doing.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
160.	Feeling as if my actions serve the wishes of others rather than my own.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
161.	Having faith in a good outcome.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[162]	Sensing that it is I who want it.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

When you are doing something difficult or unpleasant, sometimes your feelings and moods turn mostly negative or you simply feel inclined to do other things. Sometimes you may apply strategies from the outset that help you to stick it out. But on other occasions you perhaps do or imagine things that make it even harder to stay on task...

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

How do I feel when involved in a difficult project and how do I handle my moods?		This is how often I am like that:								
[163]	Being driven by fear of failure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
164.	Putting myself into the mood I need in order to keep on track.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
165.	Getting distracted by thoughts about other exciting things.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
166.	Being able to draw something positive from an activity that originally was unpleasant.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
167.	Continuing with a matter though feeling the urge to stop..	almost never	①	②	③	④	⑤	⑥	⑦	almost always
168.	Imagining how awful a failure will be.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
169.	Putting myself into a happy mood because that will help me to make much better headway.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
170.	Letting myself get distracted by more pleasant things.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
171.	Finding it difficult to suppress conflicting needs.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
172.	In spite of the difficulties, thinking of those aspects of an activity that I like.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
173.	Finding myself striving for a goal that I myself did not really decide.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
174.	Thinking of the unpleasant consequences of not having done something.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
175.	Doing something that helps me to get rid of an unpleasant mood that is blocking me from progressing towards a goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
176.	Having a hard time resisting a tempting distraction.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
177.	Thinking about the positive aspects of a goal when my determination to persevere weakens.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
178.	Feeling as if there's a lot to dislike about the project and nothing to gain from it.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[179]	Letting myself be haunted by a guilty conscience.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

How do I feel when involved in a difficult project and how do I handle my moods?		This is how often I am like that:								
180]	Deliberately thinking of pleasant things in order to become more relaxed.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
181.	Getting side-tracked by a tempting distraction.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
182.	Deliberately focusing on the positive aspects of a difficult activity.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
183.	Having a sense of detachment from the goal but still working towards it.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
184.	Thinking about what would happen if I cannot cope.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
185.	Managing my mood so that my work flows more easily.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
186.	Having a hard time postponing my other needs as they gradually crop up.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
187.	Knowing how to increase my interest in a dull activity.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
188.	Feeling unable to recall my original reasons for committing myself to a difficult goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
189.	Imagining how awful I would feel if I could not accomplish a particular goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
190.	Cheering up so that things will work out better.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
191.	Experiencing my other needs so sharply that I find it increasingly hard to stay on track.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
192.	Being unable to postpone a sudden desire.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
193.	Knowing exactly how to increase my interest in something I am doing.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
194.	Feeling compelled to go on in order to avoid unpleasant consequences.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
195.	Focusing on how it would feel to fail.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
196.	Changing my mood so that it fits better with what I have to do.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
197.	Feeling irresistibly drawn to something tempting.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
198.	Seeing good in something hard that I am doing.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
199]	Feeling committed to staying on track with something though being unable to derive positive feelings from it.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

Sometimes it can be hard to adjust to new situations and demands. This may happen if you have been occupied with one thing for a long time. Then you may or may not succeed in disengaging yourself from the old routine and in adjusting to a new one. This may also lead to errors and criticism.

VCI [7]

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

How does it feel for me to suddenly have to "switch" from one thing to another?		These days, this is how often I am like that:								
[200]	Hating to start something new as long as another important matter remains unfinished.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
201.	Making mistakes if I suddenly have to pay attention to something very different.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
202.	Being able to change my ineffective behavior after few attempts.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
203.	Avoiding getting involved in more than one thing at a time.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
204.	Only slowly perceiving what is important in a changed situation.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
205.	Being quick to learn from criticism.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
206.	Finding it difficult to switch over to something different when I am absorbed in something.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
207.	Continuing to think about something even after it is finished.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
208.	Finding it difficult to change my usual way of looking at things.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
209.	Easily making use of criticism to improve my approach to something.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
210.	Having a hard time shifting back and forth between activities.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
211.	Having a hard time when I suddenly have to follow completely new instructions.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
212.	Learning from my mistakes quickly and without hesitation.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
213.	Losing time due to repeatedly switching attention when having to work on several things at the same time.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
214.	Finding it hard to adjust again and again to new things.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[215]	Only slowly learning to change my thinking in new situations.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

How does it feel for me to suddenly have to "switch" from one thing to another?		These days, this is how often I am like that:								
[216]	Being able to change my behavior immediately when someone points out my mistakes.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
217.	Having trouble switching from working on one project to working on another, even when there is nothing more I can do at that point to advance the first project.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
218.	Finding it difficult to adjust to sudden changes of rules.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
219.	Needing little time to learn from my mistakes.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
220.	Finding it a strain having to change my accustomed ways of doing things.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
221.	Finding it difficult to change from my usual actions to new ones.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
222.	Finding it difficult when I have to turn my usual ways of looking at things upside down.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
223.	Quickly improving my performance if I can see right away where I am making mistakes.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
224.	Being unable to start something new because I am still preoccupied with a previous matter.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
225.	Finding it hard to reorient myself to a new situation.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[226]	Quickly learning from my mistakes.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

If you suffer setbacks in a challenging undertaking or if the whole thing goes wrong, there will be various consequences:

Sometimes you are completely stalled and have to keep thinking about your mistake. However, in other situations you might even feel spurred on by your mistakes and be more successful...

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

While pursuing a goal, how do I handle successes and setbacks?		These days, this is how often I am like that:								
[227]	Imagining how good I will feel after having finished the task.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
228.	Having "paralyzing" thoughts as soon as something goes wrong.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
229.	Listing for myself all the things I achieved en route towards my goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
230.	Finding myself brooding after a failure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
231.	Rewarding myself when I have successfully completed something difficult.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
232.	Fantasizing about how good it will feel to have achieved the goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
233.	Finding it hard to start all over again after a failure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
234.	Looking back at all the things I have already accomplished.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
235.	Immediately having to think of past failures after a setback.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
236.	Taking a break after having achieved something difficult.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
237.	Thinking up a reward for myself for going through the effort.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
238.	Losing all of my energy when threatened by a failure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
239.	Patting myself on the back for even small accomplishments.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
240.	Being plagued by worry when something doesn't turn out right.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
241.	Doing something nice for myself when I have made progress on a difficult project.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
242.	Enjoying the pleasant thought of reaching the goal soon.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[243]	Feeling internally paralyzed by a fear of failure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

①	②	③	④	⑤	⑥	⑦
almost never	seldom	somewhat seldom	sometimes	somewhat often	often	almost always

While pursuing a goal, how do I handle successes and setbacks?		These days, this is how often I am like that:								
[244]	Recalling the steps I have already taken that have moved me closer toward my goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
245.	Needing a long time to forget something unpleasant.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
246.	Taking the time to savor my success after a difficult activity.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
247.	Fantasizing about pleasant things to do when I have reached a goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
248.	Losing my drive after a failure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
249.	Feeling proud of myself after having mastered a difficult step towards my goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
250.	Spending a long time thinking of possible reasons for a failure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
251.	After having reached a goal, rewarding myself for my efforts.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
252.	Saying to myself: When you are done with it, you can reward yourself.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
253.	Feeling unable to do anything at all for a while after having suffered a setback.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
254.	Once in a while reminding myself of the little successes I have already achieved.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
255.	Having an unpleasant feeling for a long time after a setback.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
256.	Unable to escape my worried thoughts.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
257.	Allowing myself time off after having put out effort.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
258.	Thinking of the nice things that will happen after I reach my goal.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
259.	Mentally freezing up for fear of further failures.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
260.	Feeling paralyzed by a setback.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
261.	Celebrating each successful step of the way.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
262.	Constantly having to think of a previous failure.	almost never	①	②	③	④	⑤	⑥	⑦	almost always
[263]	Following a hard push with rest and relaxation.	almost never	①	②	③	④	⑤	⑥	⑦	almost always

APPENDIX – D

THE ACADEMIC VOLITIONAL STRATEGY INVENTORY (AVSI)

McCann, E J. and Garcia, T (1999) first developed this AVSI instrument. It has been adapted for mathematics by Molokoli D and Dr. Nieuwoudt H D (2003).

1	2	3	4	5
Almost never	Seldom	Sometimes	Often	Almost always

1. I remind myself that I usually do fine on mathematics exams, class-works, homework and projects when I stay on track with my mathematics studying.	1	2	3	4	5
2. While faced with mathematics problem I tell myself, "You can do this!"	1	2	3	4	5
3. I think about my mathematics homework that if I don't get going or continue this study session I will fall behind in my continuous assessment mark.	1	2	3	4	5
4. I tell myself that I have obtained my best mathematics grades when I stuck to a study schedule.	1	2	3	4	5
5. I think about the mistakes that I have made on past mathematics homework, class-works and exams when I have procrastinated in my studying.	1	2	3	4	5
6. I think about how relieved I will feel when I get this mathematics problem finished.	1	2	3	4	5
7. I tell myself, "Get to it and concentrate; this is an important mathematics exam / homework."	1	2	3	4	5
8. I tell myself that I will have enough time to talk to my mathematics teacher or classmates for help if needed, if I just get back to my studying.	1	2	3	4	5
9. I think about how disappointed others (family/friends) will be if I do poorly in mathematics.	1	2	3	4	5
10. I think about why I am doing mathematics (e.g., about my future plans).	1	2	3	4	5
11. I think about the kinds of jobs / career I may end up with if I fail mathematics.	1	2	3	4	5
12. I think about the sacrifices that I have made or that my parents are making to put me through studying mathematics.	1	2	3	4	5
13. I think about the goals I have set for myself (how I perform in mathematics may affect my future).	1	2	3	4	5
14. I think about the possible negative consequences of doing poorly in mathematics class.	1	2	3	4	5
15. When I can't get down to studying or if I get frustrated or interrupted practicing mathematics, I count to 10 to help me get on track with it.	1	2	3	4	5
16. I talk aloud to myself about the mathematics material I am studying to					

keep me from getting distracted by other thoughts or activities.	1 2 3 4 5
17. I call a friend from class and discuss mathematics class-work or homework with.	1 2 3 4 5
18. I exercise for about a half-hour before I begin studying mathematics to clear my head and help me get relaxed.	1 2 3 4 5
19. I imagine myself moving through mathematics homework or answering the test questions without difficulty.	1 2 3 4 5
20. I think about the amount of time my classmates probably study mathematics for this class, and that they will get a better grade than I will.	1 2 3 4 5
21. I schedule regular mathematics study hours with a friend from class so that I won't fall behind on my class homework and feel bad / stressed / guilty for putting off studying.	1 2 3 4 5
22. I promise myself something I want when I complete working on a certain number of mathematics problems (e.g., getting together with friends, playing music I favor, watching TV, etc.).	1 2 3 4 5
23. I think of interesting or different ways to make mathematics learning more fun or challenging for me.	1 2 3 4 5
24. I tell myself that I will be able to understand and remember this mathematics section.	1 2 3 4 5
25. I think about things that make me feel good whenever I am feeling frustrated about what I need to get done for mathematics lessons.	1 2 3 4 5
26. I think about my strengths and the resources that I can draw upon to help me with difficult mathematics problems or test information.	1 2 3 4 5
27. I take a 5 to 10 – minute break to clear my head when I want to quit studying mathematics but know I should stay with it.	1 2 3 4 5
28. While doing mathematics I put on background music (e.g., soft, and instrumentals) to relax me.	1 2 3 4 5

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TEL : 014 552 1550

P. O. BOX 8512
RUSTENBURG
0300

13.02.02

DISTRICT MANAGER
DEPARTMENT OF EDUCATION
P/BAG X82110
RUSTENBURG
0300

Dear Sir

APPLICATION TO DO RESEARCH WORK IN HIGH SCHOOLS

As a part-time M. Ed (Mathematics Education) student registered with Potchefstroom University I seek permission to carry on research work in Grade 10 Mathematics classes at the following schools:

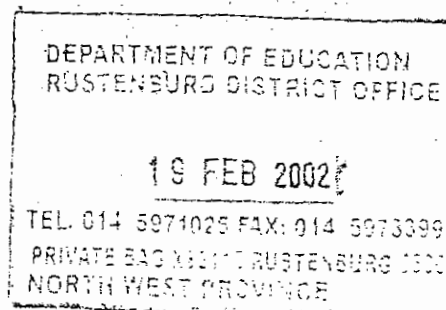
Semetsa High Khayaletu High

St. Annes High Rustenburg Technical High

The main aim of the research work is to establish contribution of learner volitional resources to meaningful and effective mathematics learning. The results of the research are envisaged to lead to appropriate teaching and learning skills that will enhance mathematics performance in school.

Yours faithfully

D. L. Molokoli
RESEARCHER



PERMISSION GRANTED

[Signature]

ADM

19/02/02



Founding 1869
50 years of independence 2001

Potchefstroomse Universiteit

vir Christelike Hoër Onderwys

Potchefstroom University
for Christian Higher Education

Prof. Julius Kuhl
Department of Differential Psychology
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Tel (018) 299 1111 Fax (018) 299 2799
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<http://www.puk.ac.za>
Graduate School of Education

Tel (018) 299-1905
Fax (018) 299-1888
E-Mail nsohdn@puknet.puk.ac.za
3 June 2003

Dear Professor Dr. Kuhl

LETTER OF CONSENT: USE OF INSTRUMENTS FOR RESEARCH

Thank you very much for being willing to send us English versions of the instruments and manuals of the *Operant Multi-motive Test* and the *Volitional Components Checklist*. As requested, I hereby confirm in writing that we will use the (copyrighted) instruments for research purposes only, never for clinical or organizational purposes that include a honorarium, and that we will not hand the instruments to a third party.

We fully understand that copyright agreements compel you to request the confirmation from us. We sincerely appreciate your cooperation in this respect.

Yours sincerely

Hercules D Nieuwoudt, PhD
Associate Professor: Mathematics Education

NSOHDN c:\documents and settings\all users\documents\navorsing\omt-vckkuhl2003a.doc

Hercules Nieuwoudt - Re: English versions of the Operant Multi-motive Test (OMT) and the Volitional Components Checklist (

From: Julius Kuhl <Julius.Kuhl@t-online.de>
To: "Hercules Nieuwoudt" <NSOHDN@puknet.puk.ac.za>
Date: 6/2/2003 2:06 AM
Subject: Re: English versions of the Operant Multi-motive Test (OMT) and the Volitional Components Checklist (

Dear Hercules,
 the fax number is: +49 541 969 4788.
 Regards
 Julius Kuhl

"Hercules Nieuwoudt" <NSOHDN@puknet.puk.ac.za> schrieb:

> Dear Julius

>

> Thank you for the positive response to our request. I will certainly send such a letter to you as soon as possible. Would it possible to send it by fax too? If so, will you please provide me with a fax number to use. Of course, the original letter will in any case be sent to you as well.

>

> Kind regards

>

> Hercules

>

> >>> <Julius.Kuhl@t-online.de> 05/29/03 10:19PM >>>

> Dear Dr. Nieuwoudt,

> I can send you the instruments and manuals you requested as soon as I receive a printed letter of consent from you in which you confirm that you will use the (copyrighted) instruments for research purposes only, never for clinical or organizational purposes that include a honorarium, and that you will not hand the instruments to a third party. I am sorry that copyright agreements compelt me to request this confirmation from you.

>

> Best wishes

> Julius Kuhl

>

>

>

> "Hercules Nieuwoudt" <NSOHDN@puknet.puk.ac.za> schrieb:

> > Dear Professor. Kuhl

> >

> > A masters' student, David Molokoli, working with me in Mathematics Education is investigating Black learners' use of volitional strategies in particular contexts of grade 10 geometry teaching and learning. The research intends to contribute towards eradicating some of the teaching-learning problems experienced in historically disadvantaged South African schools. In David's reading we came across the work done by you and others at the University of Osnabrück, and we are particularly interested in two instruments mentioned in your work (and above in the Subject line): the OMT and VCC. Unfortunately we struggle to access (English) sources that contain the instruments, as well as more information about them and their use.

> >

> > May we cordially enquire whether it is possible to obtain the instruments and information directly from you? If so, will you please inform us about how this could happen?

> >

> > Thanking you in advance for your assistance

> >

> > Kind regards

> >

> >

> >

> > Hercules D. Nieuwoudt, PhD

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> > Graduate School of Education

> > Potchefstroom University

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> >

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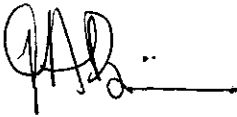
>

TO WHOM IT MAY CONCERN

I hereby declare that I have edited the dissertation of Mr. DL Molokoli.

Certain alterations and corrections have been suggested. However, since I have not seen the final product, I have no proof that these suggestions have been followed and cannot be held accountable for faults that may not have been corrected.

Yours

A handwritten signature in black ink, appearing to be 'JA Bronn', followed by a horizontal line.

(Ms JA Bronn, MA. SAIVERT no.448)