A model for enhancing volitional strategies' use and mathematics achievement in Grade 9 in a rural community school

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DEDICATION

To my late Father, Meshack Molokoli, and late Mother, Julia Molokoli who were instrumental in my up-bringing and taught me that the Fear of God is beginning of wisdom.

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DECLARATIONS

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STATISTICAL CONSULTATION LETTER

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We hereby confirm that the Statistical Consultation Services of the North-West University had analysed the data and assisted with the interpretation of the results. However, any opinion, findings or recommendations expressed in this document are those of the author and the Statistical Consultation Services of NWU (Potchefstroom Campus) do not accept responsibility for the statistical correctness of the results reported.

Kind regards

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ABSTRACT

Key words: Volition, constructivism, emotion, planning and initiate, achievement, effort, persistence, self-control, mathematics learning, cognition, self-efficacy, implementation intention, attention control, self-efficacy and failure control.

The contextual factors that affect effective Mathematics learner engagement patterns are due to lack of self-regulated learning and enthusiastic volitional use. An active role for Mathematics learners incorporates use of volitional strategies towards knowledge construction. Self-regulated learning is an important factor for effective learning. However the PISA (2004) survey noted the problem of deficits in cross-curricular academic competencies, which included general self-regulatory strategies. The continued poor performance of learners in mathematics in South Africa at different school levels, especially grade 9 calls for different approach to learning. This research argues that enhanced application of volitional strategies is possible and, in fact desirable if learning situations have to promote mathematics achievement in areas with a presence of traditional teaching style. The purpose of this study is to construct volition enhancing self-regulation model to improve grade 9 mathematics learner performance in rural community schools.

The model suggests combining precepts from activity theory and constructivist views as basis. The cyclic learning states of pre-action, action or volition control, and pro-action phases emanating from self-regulation sequence of self-monitoring, self-evaluation and self-reflections form the key concept of the volition model. However the sustained view maintains the education system model as proposed by Howe (2004:153) that includes input, processes and output contributing towards mathematics achievement. Hence the volition model considers the characteristics of teacher, implemented curriculum, teaching and instruction among its components to advance an understanding of their influence in mathematics performance.

A mixed method research design, in which quantitative and qualitative are combined to achieve the outcomes of the research problem, is chosen for this research study project to provide a purposeful research framework. The finding revealed that the overall Volition Component Inventory (VCI) in pre - / post - and retention tests displayed good reliability, acceptable communality and acceptable construct validity for the VCI questionnaire. The post-test findings using the Univariate Tests of Significance, Effect Sizes, and Powers with partial eta^2 values comparing experimental and control groups indicate the intervention effect of high statistical

significance suggesting that the educational intervention enhanced mathematics performance. Another findings on how the experimental and control groups compared on learner VCI fields for in pre - / post - and retention tests using Least Square means crossover design model indicate that the enhanced intervention for volition self-efficacy, emotion control, failure control and self-control pressure, energy usage, planning and initiating ability and attention control was of significant main effect. Also the findings between control and experimental group using a three way and nested ANOVA on both learner use of volition strategy use in pre - / post – and retention test indicate pre-test to post-test, a sharp increasing effect of intervention. Hence the results revealed that it is possible to support volition mode of self-regulation competencies and mathematical achievement by self-regulation intervention within regular mathematics lessons of grade 9 learners. Furthermore the findings from the quantitative and qualitative data-analysis and interpretations, and literature review, guided the researcher in proposing a construct for volition enhancement self-regulation model to improve mathematics learner performance in grade 9 rural community schools.

In this context, our study adds to research as it realizes that mathematics learning can be directly influenced by combining mathematics related strategies with cross-curricular self-regulation strategies in order to improve learner performance.

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CHAPTER 1

STATEMENT OF THE PROBLEM AND STUDY PROGRAMME

1.1 STATEMENT OF THE PROBLEM AND MOTIVATION

Central to Mathematics teaching and learning is the development of mathematical process skills of investigating, conjecturing, organizing, analysing, proving, problem solving and modelling. During Mathematics learning the process skills are best achieved if learners are active and willingly execute appropriate actions towards goal attainment. During problem solving, for example, appropriate decision making and initiation of intended actions that are aimed toward goal achievement, are well implemented by willing learners. The problem solving learner phases that advance decision making include formulation of strategy through planning.

Corno (2005:201) hint that self-regulated learners are engaged actively and constructively in a process of meaning generation and that they adapt their thoughts, feelings, and actions as needed to affect their learning and motivation. However the PISA - survey (Program for International Learner Assessment; e.g., PISA. 2004) addressed the problem of deficits in cross-curricular academic competencies, which included general self-regulatory strategies. The results of this study revealed the need for learners to learn how to be self-regulated. Self-regulation demands willingness that propels learners executes planned actions and subsequently maintain and implement their own intended decisions. According to Diefendorff and Lord (2003:383) goal-setting explanations for planning effects in strategy development and enhanced volitional processes do impact goal-directed activities. Therefore decision making during Mathematics learning demands maintenance of learner volitional reactions.

However, most learners at secondary schools are ill equipped with regard to carrying out appropriate volitional responses as revealed in an earlier study conducted in four schools in Rustenburg (Molokoli, 2005). The lack of enthusiastic volitional approach affects learners' thinking in Mathematics and ultimate individual mathematical achievement. Even though research does not reveal much understanding on both the strategic and volitional benefits during mathematics learning, Kehr (2004:485) suggests that volitional regulation is needed to support higher order cognitive preferences which are learner goals or intentions. In recent approaches to volitional regulation, scholars have considered intrapersonal conflicts from conflicting behavioural tendencies and the strategies people use to overcome them (Kanfer & Heggestad, 1997; Kehr, 2000; Kuhl & Fuhrmann, 1998; Kuhl & Goschke, 1994; Metcalfe & Mischel, 1999; Muraven & Baumeister, 2000).

In the research mentioned earlier, seven volitional strategy categories that impact on learner mathematical achievement were identified in different school contexts during Mathematics learning (Molokoli, 2005:124). These are self-control pressure, lack of energy, planning and initiating, intention monitoring, emotional control, failure control, attention distractibility and volitional self-efficacy. In some mathematical learning contexts the degree to which learners make use of the seven mentioned volitional strategy categories differ; hence, mathematical achievement is adversely affected. Recent research as well highlights the need to use volitional strategies to boost goal striving (Turner & Husman, 2008:145).

The significant role of volition is emphasized by Wolters and Rosenthal (2000:817) who state that learners' use of volitional strategies serves as one mechanism through which attitudes translate into greater effort and persistence at academic tasks. Kuhl (2000:668) reiterates that volition refers to the activities involved in maintaining and controlling action while striving for goal-attainment. Hence the concept of volition relates to internal maintenance of effort, to emotional aspects of a learner, and incorporates self-regulation. A broad perspective as suggested by Corno (1993:16) posits volition as a system of psychological control processes that protect concentration and direct effort in the face of personal and / or environmental distractions, and so aid learning and mathematical achievement. Other researchers like Eccles and Wigfield (2002:124), as well Teo and Quah (1999:25), consider volition to entail self-regulatory strategies to support explicit action tendencies against competing behavioural impulses. Other researchers relate the concept of volition to willpower (Metcalfe & Mischel, 1999), self-control (Muraven & Baumeister, 2000), and self-regulation (Kuhl & Fuhrmann, 1998; Kehr, 2004:485). Moreover Panadero and Alonso-Tapia (2014:451) assert that in the same way that learners can learn to control their own motivation it is necessary to include volition in the definition of self-regulation.

In light of the advanced research cited on volition it is worth paying more consideration to learner use of volitional regulation in the embedded context within which mathematics learning occurs. This is with a view to resolve conflict where extra-personal difficulties surpass certain thresholds and Mathematics learning becomes difficult to achieve. Therefore it is important to understand for example how context prevalent in the teaching approach makes use of emotional factors to promote Mathematics learner interest in the midst of encountered challenges. Reed, Schallert and Deithloff (2002:53) as well as Schallert, Reed and Turner (2004:1726) contend that, through invoking volitional strategies to initiate or maintain learning activities, learners can become actively engaged in learning. However there is dissatisfaction with the ways in which prevalent mathematical contextual practices at schools enhance learner participation through application of energy spent on planning and initiating as well as on intention monitoring (Molokoli, 2005:124). As a result it is herein conceived that such treatment prevents many learners from being self-regulatory and even from accessing mathematical understanding. Thus, it is important to have in-depth insight in understanding how learners integrate energy, planning and own initiative means as they overcome intrapersonal barriers in order to maintain Mathematics learning intentions.

Moreover, there is dissatisfaction with the ways in which prevalent contextual practices at schools enhance learner failure control and emotional control measures during Mathematics learning (Molokoli, 2005:126). Both failure and emotional control are of utmost importance in assisting learners to become more resilient, and not to lose hope but continue working even after failure. According to De Corte, Verschaffel and Opt Eynde (2000:696) self-regulation of emotional aspects of the learning and the problem solving processes require competence to monitor and control one's volitional processes. Not all Mathematics educators are conversant with appropriate ways to support Mathematics learners in reaction to failure to infuse new effort. There is not much research that addresses secondary school learners' understanding and use of volitional strategies. Hence there is a need to better explore how learners uses self-control to apply pressure to themselves to facilitate improved access to Mathematics process skills. By doing so we intend to make up for a lack of research about developmentally appropriate self-control pressure, lack of energy, planning and initiating, intention monitoring, failure and emotional control, volitional self-efficacy and attentional distractibility strategies as well as their orientation to mathematical thinking processes.

There are conditional contextual factors that differentiate classroom learning engagement patterns in which learners are successful in mathematics from those in which they are less so. How then can we assist learners move successfully from unproductive learning situations to more productive ones? Augmenting the lived experience of learners is intended to add to planning and initiating operations learners use to access Mathematics learning strategies. This will reinforce learner means of intention monitoring practices that serve to define and constrain their mathematical thinking, and ultimately assist learners to improve their self-evaluation whilst acquiring Mathematics learning process skills.

Hence the purpose of this research was to first develop volition enhancement intervention strategy that will augment Mathematics teaching and learning. Secondly to implement intervention strategy during teaching and learning of Mathematics in selected grade 9 classes. Thirdly to evaluate and assess the effect of the applied volition enhancement strategy on learner mathematical achievement. Lastly to gain insight on how application of volition enhances teaching and learner achievement in grade 9 Mathematics. These goals were considered with the intention of suggesting ways that would assist learners who struggle with the learning of Mathematics in rural schools.

In a nutshell the research study entailed examining the effects of learner self-control pressure, energy usage, planning and initiating ability, intention monitoring, failure control, emotional control and attention control on Mathematics achievement. An analysis was made specifically of the effects of these variables on learners' volitional self-efficacy, satisfaction with their mathematical achievement, rating of the instruction they received and attributions of success or failure in acquiring the mathematics process skills they were taught.

In this regard an assertion that learners must develop their volitional strategies through frequent use and must be supported by their teachers in their application during Mathematics learning was made. Therefore the research study promotes the requirement to include in the curriculum these volitional transitional skills that support learners access to learning strategies. In order to achieve the main purpose the research question was posed: Can learners' Mathematics-related volitional use be enhanced through an educational intervention in an innovative learner view on self-management? In other words, can learner volition use be refined? Can learners' self-evaluation of their own effort and understanding in Mathematics also be improved through the educational intervention? Can Mathematics learning be different if learners' use of self-control pressure, planning, initiating and intention monitoring, failure and emotional control and attention control is supported? Do learners' volition use predict their achievement in Mathematics? Therefore a mixed method research approach is to be used towards achieving this aim. The research approach will include the use of quantitative and qualitative approaches to examine learner reactions to the implementation of the proposed self-management programme.

1.2 REVIEW OF RELEVANT LITERATURE

The Accelerated and Shared Growth Initiative for South Africa (AsgiSA) was born out of the need by government to help support South Africa's rapidly expanding economy (SA Gov. Info.). The Department of Education developed a national strategy on mathematics, science, and technology (NSMST) to create schools of excellence or focused schools, 'Dinaledi' schools with targets to produce more mathematics and science learners. This is a medium-term educational intervention to address problems, such as under-qualified teachers and too few learners taking mathematics and science related subjects, a number of initiatives and programmes have been developed at national and provincial levels as well as by higher education institutions (Mji & Makgato, 2006:255). Dinaledi project is a curriculum initiative with intend to address special priority areas: there are now over 400 designated Dinaledi schools that are being groomed as centres of excellence in mathematics and science (Motala et al. 2007:39). The Dinaledi Focus Schools Project is part of the National Strategy for Science, Mathematics and Technology, to increase the number of learners studying mathematics and physical science in Grades 10–12; to increase the number of higher grade learners in these subjects — especially girls and formerly disadvantaged learners; to increase the pass rate and achievement in mathematics and science in these grades; to develop the capacity of the mathematics and physical science teachers (Western Cape Department of Education, 2005). In the light of what is stated Mathematics teaching and learning is a matter of National concern in South Africa.

The researcher is of the opinion that poor achievement in Mathematics is attributed to several factors that may be embedded in one or more of these four main elements, namely the teacher, learner, content and/or context. School learning context strongly affects aspects of study orientation (Molokoli, 2005:153). Indeed, Steinbring (2005:314) makes an assertion that the inter-relatedness may exist amongst the four named elements impacting on learner mathematical achievement, but this is notwithstanding learners' cognitive aptitude. Hence my main focus in this research study will be on some factors involving the learner and context, but ascribed to volitional influence during mathematics learning process. These factors are planning and initiating, intention monitoring, attentional distractibility, self-control pressure, failure and emotional control, and volitional self-efficacy.

The psychological construct volition, as research reveals, is concerned with the learner implementation of intentions and is characterised by self-regulation activities of purpose striving (Corno, 2004:1672). The Oxford Dictionary defines volition as 'the act of exercising will, the ability to choose or to make conscious choices or decisions'. For this reason Teo and Quah (1999:25) emphasize that volition is the mental act of exercising one's will, and refers to power of choosing or determining action. This is echoed by Eccles and Wigfield (2002:124) who denote volition as the strength of will that is needed to complete a task, and the diligence of pursuit (also see section 2.3). More recently, the concept has been expanded to include initiating and sustaining engagement along with motivation and volition (Spector & Kim, 2014:9)

In the process of Mathematics learning the significant role of learning strategies is acknowledged. The learning strategies include any thought, behaviours, beliefs or emotions that facilitate the acquisition, understanding or later transfer of new knowledge and skills (Weinstein, Husman, & Dierking, 2000:733). But with regard that the will component has a significant role to play during Mathematics learning, knowledge about strategies and knowledge of the contexts the strategies are to be used in, is not enough. Indeed Weinstein *et al.*

(2000:741) assert that the learner must also want to use the strategy. Hence in this research the contributing role of volition to Mathematics learner competence and wilful affect to work through during Mathematics learning is investigated. The volition role is scrutinised whilst learners are executing mathematical process skills. However, well equipped Mathematics learners are persistently involved in mental activity of monitoring and controlling their behaviours, cognitions, motivation, and emotions to improve their own mathematical achievement (Hannula, 2006:168). Motivation allows goal setting and volition allows goal striving (Kim & Bennekin, 2013:795). In this study volition role is discussed in three categories of (a) pre-phase that includes learner planning and initiating mathematical activities, (b) mid-self-checking phase of monitoring own intentions, attention control, and (c) management and control of effort that involves self-control pressure, emotion control, failure control and volitional self-efficacy.

1.2.1 Pre-action phase volition role – Planning and initiating

The learning phase that is characterized by plans to initiate the behaviour at a specific time and place is volitional (Pape, Bell &Yetkin, 2003:182). Planning is the foremost important aspect of the Mathematics learning process necessary for effective implementation and accomplishment of procedural learning skills. Prior to execution of learning strategies, planning approach prompts learners to be engaged in a thinking process. Volitional effects of planning (Bargh & Gollwitzer, 1994; Gollwitzer, 1999; Gollwitzer & Schaal, 1998) occur in a goal-setting context. Planning has both cognitive and volitional benefits. In agreement Diefendorff and Lord (2003:366) add that the intellectual benefits of planning involve developing a strategy to achieve a goal, whereas the volitional benefits involve increased persistence and confidence, decreased distractibility, and a readiness to seize opportunities to act. Hence Mathematics learners' lack of energy, planning and ability to initiate influence their mathematical achievement (Molokoli 2005:124). In addition, Turner and Husman (2008:142) suggest that goal-striving processes require on-going planning, monitoring of progress and evaluation of goal-related feedback.

Recently however,Gollwitzer and Brandstätter (1997);and Orbell and Sheeran, (2000) have also shown that the volitional benefits of planning help people to overcome problems of action, such as getting started on a task, persisting despite difficulties, and completing tasks faster. In addition (Gollwitzer & Brandstätter, 1997; Orbell, Hodgkins, & Sheeran, 1997; Sheeran & Orbell, 1999) empirically established and fine-tuned the assumption that planning an action increases the likelihood that it will be eventually performed. In accordance with research work by Dewitte, Verguts and Lens (2003:89), data suggest that knowledge of the planned steps required to reach a goal might moderate the relation between intentions of implementation and their enactment. Thus it is of importance that Mathematics learners plan for Mathematics activities including practising, preparing for a Mathematics test and / or examinations and preparing to do homework.

Planning strategy is needed to indicate how learners start working on Mathematics tasks after formulating their intentions. Subsequently learners make use of planned steps to maintain and control own actions while successfully striving towards goal-attainment. Therefore, in concurrence with Diefendorff and Lord, (2003:367) planning has some additional volitional benefits, such as protecting active intentions from interference by competing intentions, bolstering one's confidence, preventing distractions, and increasing the likelihood of timely and appropriate initiation of goal-directed mathematical activities.

1.2.2 Volition control phase–

a) Intention monitoring

One of the affective factors needed to support a fostering of Mathematics process skills is to take account of intentions that learners have towards Mathematics. Intentions signify effort concentration displayed by learners with the objective of performing Mathematics procedural skills. The researchers, Gollwitzer and Brandstatter, (1997); Orbell, Hodgkins and Sheeran, (1997); Sheeran and Orbell, (1999:355) agree that implementation intentions moderate relationships between intentions and planned behaviour. Moreover, Gollwitzer (1996) states that implementation intentions specify the where, when, and how of goal-directed activities increasing the person's commitment to carrying out the activities under the specified conditions. Forming an implementation intention basically involves setting up an "if-then" production statement whereby actions are automatically triggered when appropriate situational cues are encountered (Diefendorff & Lord, 2003: 368). Intention monitoring strategy and implementation intentions enable learners to determine whether they remember at appropriate times what is to be done, for example, which mathematical tasks are to be completed at a particular time. Implementation intentions are important components of metacognitive control of action geared towards initiation, continuation and termination (Gollwitzer & Schaal, 1998:124). When learners are skilled to monitor their intentions, the carrying out of mathematical processes is assisted by effort spent while learners concentrate on strategy use. Intention monitoring is a feature with influence that facilitates learners to exert pressure and work towards timely completion of Mathematics tasks. Thus, forming implementation intentions transfers the control of goal directed behaviour to specified anticipated environmental stimuli (Gollwitzer, & Schaal, 1998:134).

The view as herein endorsed is that volitional strategy of intention monitoring interacts with emotions to influence maintenance of intentions for learners to exert the necessary effort to work towards and up to end of Mathematics problems. The enthusiasm and choice to work towards objectives of Mathematics tasks is further determined by present and future learning intentions. The intentions are maintained subsequent to the value an individual learner attaches to Mathematics as a learning subject. Hence Mathematics learners are to be vigilant in monitoring their own intentions and knowing how to make a choice to control any negative emotions. Boekaerts and Corno (2005:206) found that learners' willingness to maintain learning intentions and persist toward mastery in the face of difficulty depends on their awareness of and access to volitional strategies (i.e. meta-cognitive knowledge to interpret strategy failure and knowledge of how to buckle down to work). Moreover, the Mathematics learning process is driven by continued mental activity made up of cognitive prompts that include elements of monitoring and control. However, the view consistent with Cobb, Steyn, McClain and Gravemeijer, (2001:121) attributes mental activity and intelligence to intention monitoring, control of thinking and emotions demonstrated by individual learners' reasoning ability.

b) Attentional distractibility

The volitional strategy of attention distractibility determines how easy or difficult it is for learners to fully concentrate on difficult Mathematics problems. These strategies inform of ways to keep learner attention on uninteresting Mathematics problems despite being excited or too nervous. The tendency of a learner to use attentional distractibility as strategy to direct concentration contributes to volitional capacity (Molokoli, 2005:125). Energy that is built from within is expended by learners to be committed to Mathematics tasks and ignore excitement. Hence learners decide to instructively pay attention to that which is important for achieving the Mathematics task at hand. Orbell (2003:97) highlights the need for mobilizing mechanisms that control attention in order to stay focused on the self-chosen activity and avoid unwanted thoughts or social demands. Indeed, Hannula (2006:168) asserts that self-regulation encompasses overall management of one's behaviour through interactive processes between different control systems of attention, meta-cognition, motivation, emotion, action and volition. But Taylor (2006:361) argues that attention is the brain's highest control system that represses distracters. Thus attention distractibility in particular during Mathematics thinking addresses a measure of how learners concentrate to pick out only the essentials to focus on.

Problem solving or conjecturing in Mathematics demands information processing. Gollwitzer's research suggests that changes in information processing associated with committing to a specific strategy like increased readiness to engage in action or decreased distractibility enhance mathematical task achievement (Diefendorff & Lord, 2003: 381). Along these lines, Orbell (2003:107) suggests that implicit attention control and conscious attention control interact with low subjective norm to enhance behavioural performance to levels similar to those obtained among people who possess high subjective norms. In this regard, in harmony with what Taylor (2006:374) believes, attention is a powerful mechanism, the understanding of which also allows considerable progress to be made in clarifying and explicating certain of the principles of information processing in the brain.

1.2.3 Self-regulation and effort control volitional phase –

c) Self- control pressure

Self-control pressure refers to those volitional strategies that are for learner goal maintenance and identified to have effect on mathematics learning. Empirical evidence from earlier research results uncovered difference of medium effect of self-control pressure between different school contexts (Molokoli, 2005:123). This implied that learner self-control pressure is of importance for achievement in mathematics. Literature as documented by Orbell (2003:97) also suggests that goal-maintenance is achieved by mechanisms of self-control. Indeed some researchers maintain volitional regulation can be associated with rigid self-control "over-control" (Asendorpf & Van Aken, 1999; cf. Kuhl & Fuhrmann, 1998; & Kehr, 2004:486). When mathematics learning objectives are set learners require impetus to strive towards these goals. The individual behavioural reactions and cognitive actions displayed during the process of thinking by mathematics learners are a matter of their effort input as a result of personal choices they make in response to goal striving. The persistence to strive towards goals displayed as learners respond translates into learner diligence. The diligent pursuit and drive towards goals demands learner self-control pressure.

Furthermore diligence is a choice determined by learner consideration to put weight behind learning goals. The importance and pursuit of self-chosen mathematical learning goals has a bearing on learner self-regulation. Since research work by Winne (2004:1881) indicates that learners as agents are purposeful, look ahead to anticipate the outcomes of engaging in particular tasks using particular tactics and strategies under particular learning environments, they choose to strive for outcomes they value and this sets a course for their engagement, establishing an implementation mind-set. Mastery striving spells out self-chosen learning goals that drive learner to steer the learning process in pursuit of being more knowledgeable in mathematics despite any obstacles encountered. Learners diligently pursue to master mathematics when it is considered to be of more value or of future interest. Moreover learners' control-related and value-related appraisals are the excellent categories organizing their motivations and emotions (Turner & Husman, 2008:163). As a result self-control pressure is likely to lead learner in directing their effort and focus towards achievement of learning goals during mathematics learning.

d) Emotion control

Volitional strategies that detect what feelings and moods learners experience while doing difficult mathematics tasks are of emotion control. As a matter of empirical evidence a large negative effect that is practically significant between emotional perseverance inhibition and mathematics test achievement amongst learners at different school contexts was observed (Molokoli, 2005:115). In addition same research revealed that mathematics learners' deployment of self-regulatory measures of emotional control, use of emotional perseverance rumination and use of stress reducing actions contribute to learner volition during mathematics learning (Molokoli, 2005:153). Therefore there is need for greater awareness and reaction against emotions as they support a fostering of mathematics process skill by influencing selection of learning strategies and hence have effect in advancing learner self-regulation. Rosetta (2000:143) purports that affective factors like emotions appear to be strongly connected with selection of learning strategies and self-regulation. The need to use volitional strategies to quell negative emotions and to boost goal-striving motivation is highlighted by Turner and Husman, (2008:145). Moreover, Gómez-Chacón (2000:166) suggests a need to contextualise the emotional reactions in the social reality that produces them.

In addition some of the dimensions of the emotional state of the problem solver that are of particular importance are, duration of emotional reaction, level of awareness of emotion influencing the solving process and the level of control of the emotional reaction (Gómez-Chacón, 2000:150). Emotional control forms an important aspect of volitional capacity as it describes learner's ability to regulate their emotional experience to ensure that they provide effort and complete academic tasks (Wolters, 2003:190). Learners' use of multiple study and volition strategies can facilitate their self-regulation of stressful emotions and failure perceptions (Turner & Husman, 2008:138).

Boekaerts (1997:24) suggests that emotional control labels learner changes in the level of arousal and their skill at adequately managing it. Also Eccles and Wigfield (2002:126) identify emotional control strategies that involve keeping inhibiting emotional states like anxiety and depression in check during learning. In this regard learners may find they need to use strategies to quell negative emotions and to boost goal-striving motivation (Turner & Husman, 2008:145). Motivation (desire to learn) and volition (follow-through learning activity) are key to positive emotions and active engagement and thus to developing the relevant internal knowledge structures and mastering challenging learning tasks (Spector & Kim, 2014:12). Emotions dictate enthusiasm and choice to work towards end of mathematics problem as well as depth in approach to learning process. Therefore in agreement emotional control determines extend to which learners' apply effort and achieve in mathematics learning.

However, in response to negative emotions De Corte et al, (2000:697) highlight that

> 'learners who possess the necessary knowledge and skills to adequately regulate their volitional processes get less distracted, know when to concentrate on what, and know how to react adequately to negative appraisals or negative experiences during problem solving without falling into dysfunctional pattern of behaviour'.

Perkrun, Goetz, Titz and Perry, (2002:91) concluded that during learning, academic emotions are significantly related to learners' motivation, learning strategies, cognitive resources, self-regulation and academic achievement, as well as to personality and classroom antecedents. Hence it is important for grade 9 mathematics teachers to assist learners deal with their emotions while they are working on challenging and difficult problems.

e) Failure control

The volitional strategies of failure control determine how hard it is for learners to adjust to new mathematics situations and demands. The extend to which learners indicate how they learn from mistakes and are able to change behaviour immediately when someone points out their mistakes determine their future achievement in mathematics. In this regard evidence pointed to a large practically significant effect between failure control scale and mathematics test achievements (Molokoli, 2005:115). But to some learners failure is a discouraging factor that diminishes learner interest while to others failure form basis for increased focus and opportunity on mathematics learning. Turner and Husman (2008:138) suggest that learners' use of multiple study and volition strategies can facilitate their self-regulation of stressful emotions and failure perceptions. In agreement literature evidence also suggests strong negative emotions associated with failure, such as anxiety or fear and excessive cognitive distraction resulting from failure, are known to impair learning and reduce mathematical achievement (Perry, Hladkyj, Pekrun, Clifton & Chipperfield, 2005:559). Since mathematics entails problem solving that may demand more than one learner attempts overcoming failure is necessary for continued and persistent approach to learning.

f) Volitional self-efficacy

The need to determine internal mind state about self while occupied with difficult mathematics problems gives rise to volitional self-efficacy. For some learners in mathematics classes problem solving is met with a feeling that individual is none worth, not capable and does not have what it takes to succeed, hence they do not want to struggle long. On the other hand some persist long as they fill their minds with thoughts of certainty that it will all come out all right in the end. Persistent learners are comfortable with culture of mathematics practice. These learners with persistent character exhibit volitional self-efficacy, a virtue of significant importance to mathematics learning. Self-efficacy expectations are self-reactions about judging one's capabilities of moving forward—organizing and executing behaviours that will lead to goal attainment in the future (Turner, & Husman, 2008:144). Earlier research results revealed medium effect difference of volitional self-efficacy amongst learners at different school contexts that suggest its mild influence on learner mathematical achievement (Molokoli, 2005:125). As a matter of fact as well Eccles and Wigfield (2002:111) assert that individual's efficacy expectations are the major determinant of goal setting, active choice, willingness to expend effort, and persistence. The view as withheld by Liu and Yan (2003:36) even identified self-efficacy as one of the main factors that is associated with stress. Hence the necessity to train learners to raise their self-efficacy and improve their attribution pattern in order to reduce the negative impact of stress.

Literature has indicated that other researchers support learner use of above categories of volitional control strategies to explain some of the professed self-regulation strategies applied during mathematics learning. This is apart from learner capabilities in mathematics and self-regulatory competencies in decision making. For example self-regulated learners in research work by Turner and Husman (2008:165) were able to exert control by using volitional strategies to initiate and maintain their engagement with the course material and perhaps because of the volitional strategies learners were able to add learning strategies to their academic self-regulation processes to adapt and to employ learning strategies that facilitated deeper cognitive processes.

However, some researchers prefer a more emphasis on self-regulation that leads to, for example the learner's self-concept. Thus, it is purported that volition (including self-regulation and metacognitive skills) can be learned and used to direct, control, or manage an individual's cognitive and noncognitive processes (Spector & Kim, 2014:14). Kim's (2013:793) volitional control support design model consists of (a) goal initiation (''Want it''), (b) goal formation (''Plan for it''), (c) action control (''Do it''), and (d) emotion control (''Finish it''). But we propose that what is more elaborate and needed to help learners in secondary schools move successfully from conventional mathematical thinking to unconventional practices is application of volitional strategies. In this regard a key question is posed, how would mathematics learner achievement be different if learners' use of planning and initiating, intention monitoring, intentional distractability, self-control pressure, failure and emotional control, and volitional self-efficacy was supported? Hence the following questions are put forth:

- What mathematical strengths and weaknesses would learners develop if their sense of planning and initiating, intention monitoring, attentional distractibility, self-control pressure, failure and emotional control, and volitional self-efficacy use were developed?
- What are the effects of self-control pressure, planning and initiating, intention monitoring, failure and emotional control, attention control on learners' volitional self-efficacy on learner mathematical achievement?
- How does application of the developed influence enhance teaching and learner achievement in grade 9 mathematics?

1.3 PURPOSE OF THE STUDY

The purpose of this research was to develop, implement and evaluate a model to enhance learners' volitional strategies use as to augment mathematics teaching and learning achievement in grade 9 in a rural community school.

1.3.1 Research objectives

The broad aim is divided further into sub-goals that will assist to realize the primary aim of the research study.

a) To develop a mathematics teaching and learning model that will support learner use ofvolitional strategies..

b) To identify mathematical strengths and weaknesses learners develop when their sense of use of volitional strategies is increased.

c) To examine the effects of volitional strategies' useon learner mathematical achievement.

d) To determine how application of the developed model influences teaching and learner achievement in grade 9 mathematics.

The application of volitional strategies is needed to help learners in secondary schools move successfully from conventional mathematical thinking to unconventional practices. Therefore the key question, how does grade 9 learner use of volitional strategies influence mathematics achievement? Is further broken up into specific sub-questions that in grade 9:

- How would increase in sense of planning and initiating during mathematics learning influence learner performance in learners with less sense of planning and initiating?
- How would heightened sense of intention monitoring during mathematics learning influence learner performance with less sense of intention monitoring?
- How would fostered awareness of directing attention during mathematics problem-solving influence performance in learners who are easily distracted?
- How would learners encouraged in exerting more self-control during mathematics problem-solving influence performance in learners who easily abandon or avoid tackling problems?
- How would strengthened tendency to control failure and emotions during mathematics activities influence performance in learners with less tendency to control failure and emotions?
- How would enhanced volitional self-efficacy influence mathematics performance in learners with low self-efficacy?

1.4 METHOD OF RESEARCH

1.4.1 Literature review

An intensive and comprehensive study of the relevant and recent literature was done to analyse and discuss the inter-relatedness of volition, mathematics process skills and achievement in mathematics.

This research was supported by several theoretical and empirical studies undertaken by other researchers on mathematics learning, volition and its effects on achievement in mathematics. A theoretical link between volitional strategy use, mathematics process skills and effective learning of mathematics was developed, using primary sources.

The following databases were used to obtain the most relevant and recent literature regarding the research project:

- North West University Libraries in Potchefstroom campus
- ERIC (Published by Silver Platter)
- International ERIC (The Dialog Corporation)
- Internet service using Google Advanced and Google Scholar
- Social sciences index (SSI)
- EBSCOhost (Premier Search).

The following keywords or phrases did inform the search process:

Volition, constructivism, emotion, planning and initiate, achievement, effort, persistence, self-control, mathematics learning, cognition, self-efficacy, implementation intention, attention control, self-efficacy and failure control.

1.4.2 Research design

A pragmatic design is used to offer the mixed methods approach a set of philosophical tools that are particularly useful to deconstruct the supposed incompatibility of quantitative and qualitative methods. Hence in this research study a quantitative approach supplemented by a more qualitative approach is implemented. This mixed method is an approach to inquiry in which both quantitative and qualitative data were linked in some way to provide a unified understanding of a research problem (see section 4.3.1). A multi phased process of both quantitative and qualitative methods was used in combination of data collection in response to research questions. This research is divided into five phases, in a crossover design model (See Table 4.1). The quantitative part includes summative pre- and post-retention test and pre- and post-retention and the qualitative part includes classroom observations and clinical interviews (see section 4.9).

1.4.3 Population and sample

The crossing over research design embraces grade 9 learners from two rural schools taking mathematics. The research study target is 150 grade 9 mathematics learners in two different public secondary schools situated in Rustenburg district of the North West province. Learners from these areas are from a background of low socioeconomic status, scored below average mathematical achievement in previous years' grade 12 results, often struggle to understand mathematics concepts and completing homework. Both schools are situated in vicinity to researchers' work place.

In order to study the effect of the intervention programme extreme learner cases particularly on mathematics achievement are chosen and analysed. Thus interviews involve three best achieving and three low achievers in the school. In this regard the effect of the intervention programme is disclosed from its extremities to arrive at an understanding of the programme as a whole. The descriptive statistics and inferential statistics are used with the help of the statistical consultation service (SCS) of NWU to arrive at answers to the research questions.

1.4.4 Measuring instruments

The instruments to evaluate the implementation and effects of the volition self-regulation enhancement model involve use of survey questionnaires that capture volitional propensity. The questionnaire is adapted from and with selected parts of Volitional Component Inventory, (VCI) by Kuhl and Fuhrmann (1998:26).

1.4.4.1 Instrument 1 (Pre-and Post- Retention VCI questionnaire)

This instrument is made up of the domain – specific questions that contain Likert-type scales to assess frequency of learner reported strategy usage. In particular some Likert-type scales included reported learner meta-volitional strategies use in close connection to planning and initiating, intention monitoring, attention control, failure and emotional control and their technique for regulation of effort in mathematical lessons (Kuhl & Fuhrmann, 1998:26). The primary aim of using the VCI questionnaire is to answer the research aim 1.3.1(c) as outlined in section 1.3.

1.4.4.2 Instrument 2 (Pre-test, Post-test & Retention test)

The instruments involving quantitative methods included making use of cognitive-oriented ways like standardised mathematics tests as a measure of learners' achievement. Some summative pre- and post-retention mathematics quarterly tests set by the mathematics specialist in Moses Kotane Area office are used, see Appendix A, B and C. Tests are used to detect trend in learner achievement. The primary aim of the mathematics test is to answer the research aim 1.3.1(d).

1.4.4.3 Instrument 3 (Observation notes and observation tool)

The qualitative research methods involve face to face interaction means of collecting data by conducting detailed clinical interviews with learners. The record of reflection meetings, clinical interviews and classroom notes is kept. Discussions on examined learners work and notes that highlight their reported strategy use is made in order to inform decisions on format of the intervention programme and observation tool.

1.4.5 Data analysis

With the help of NWU SCS descriptive and inferential statistical techniques are used to organise, analyse, and interpret the quantitative data for both the pre-and post-retention test instrument and the pre-and post-retention VCI questionnaire (see section 4.8). For the analysis of the qualitative section of the research, the researcher will use records from field notes of class visits conducted (see par 4.8).

1.5 RESEARCH ETHICS

The ethical aspects involve first obtaining permission from the North West Department of Education, the Bojanala Region, the principal and teachers to be involved, School Governing body and the parents of learners (and the learners) that are selected to conduct research work at two schools in Moses Kotane East Area Project Office. The second aspect entails stating in the letter the purpose and aims of the research study.

The participating learners were reassured of confidentiality and anonymity so to protect them from any physical and psychological harm. Furthermore it was clearly communicated that participation was voluntary but we needed them to freely give informed consent about their right to participate and use of data. Then it was explained to learners their role and involvement in answering written questionnaires, participating in classroom discussions, answering interview questions and that their permission to proceed was required. The participants were informed that feedback of the findings will be made available to them.

The researcher was granted permission by the NWU Ethics Committee to conduct the research.

1.6 CHAPTER FRAMEWORK

This part intends to summarise the research study that follow.

Chapter 1:

Introduction, problem statement, aims and plan of research

In chapter 1, the research is introduced, and description of the problem statement is followed by a brief literature review. The research aims and key questions are given and the brief description methodology is given as a means to provide possible answers to research questions.

Chapter 2:

Influence of volition strategy use on mathematics learning

In chapter 2, the focus is placed on understanding the upheld learning view that encompasses the constructivist approach and activity theory. The concept of volition is defined and role in relation to mathematics learning.

Chapter 3:

Foundational bases for developing volition enhancement model

In chapter 3, the focus is on some of identified mathematics teaching and learning strategies. Special attention is given to contributory factors that lead towards mathematics achievement is made with view to developing the volition enhancement model. A discussion on the interconnectedness of learner use of volitional strategies to mathematics teaching and learning is made.

Chapter 4:

Research design and methodology

Chapter 4 provides the research design and a methodological perspective on achieving the objective set out for this study. This chapter will look into the methodology used in gathering data for this study.

Chapter 5:

Results, Data Analysis and Interpretation

This chapter presents the results, discussion on the data analysis of this study.

Chapter 6:

Summary, findings, recommendations and limitations

This chapter 6 will present a summary of the research, findings, recommendations for further research and limitations encountered during this study.

CHAPTER 2
INFLUENCE OF VOLITION STRATEGY USE ON MATHEMATICS LEARNING

2.1 INTRODUCTION

The concern about the quality of South African Mathematics achievement motivates the need to address maladaptive learning methods. In order to make a valuable contribution towards improvement in achievement this chapter makes reference to both activity theory and constructivist learning views as basis for Mathematics teaching and learning. The concept of volition is defined and its role in relation to self-regulatory and effort management skills during Mathematics learning is discussed. More literature review is made on the volition mode of self-regulation that is categorised into pre-action phase and post action phases. Furthermore the documented literature in support of need to use identified volitional strategies in Mathematics teaching and learning is made. The volitional strategies needed by Mathematics learners are identified as planning and initiation, self-efficacy, intention monitoring, attention control, self-control pressure, emotion control and failure control

2.2 UPHELD LEARNING VIEW

2.2.1 Activity theory as basis for Mathematics teaching and learning

The upheld teaching and learning view considers targeting both learner understanding and teaching in meaningful ways to be the motives for improving Mathematics teaching and learning. In order to move towards realising meaningful teaching ways, activity theory is used to explain how the named motives may be promoted during Mathematics learning. This is also in keeping with Pape, Bell, and Yetkin (2003:180) who suggest that the new goals for Mathematics education are to emphasise conceptual understanding, strategic competence, adaptive reasoning, productive dispositions and procedural fluency. But when expanding and directing thought towards the upheld educational processes by which a theory is derived, Jaworski and Potari (2009:222) highlight that the individual's conceptual development comprises personality, forms of thinking, consciousness and is also a product of his/her own activity. In this regard Van Oers (2001:71) points out Mathematics activity as "an abstract way of referring to those ways of acting that human beings have developed for dealing with the quantitative and spatial relationships of cultural and physical environment". Furthermore the need to include activity theory in Mathematics teaching and learning is prompted by Hershkowitz and Schwarz (1999:67) who mention that an activity contains various artifacts (e.g. instruments, signs, procedures, methods, laws, forms of work organisation) through which actions on objects are mediated. Hence the cultural activity theory is invoked to explain how a teaching approach that emphasizes understanding and meaningful ways may contribute towards Mathematics learning.

An activity theory is a framework for studying different forms of practices as developmental linking of individuals and social levels. The concept of activity is based on any motivated object-oriented human enterprise with its roots in cultural history and depending for actual occurrence on specific goal-oriented actions. Beswick, Watson and De Geest (2010:155) propose that activity consists of a group of people engaged in a common purpose (the subject: in this case the teachers), the direction of their work (the object or motive: in this case the Mathematics learning of their learners), the goal-directed actions which are needed to achieve the object, and the operations, or routines, which keep the system working fluently. Therefore an activity is a form of doing which is directed to an object. But activities are considered chains of actions that are related to the same object and motive. Despite Roth's (2010:284) preference for the term activism to activity, allusion is still made that it is realised by concrete actions, which are organised by and oriented to goals. The subjects of activity which are group or individual members of activists, consciously set goals, while the actions that constitute an activity are energised by its motive and are directed toward conscious goals. Furthermore, Roth (2010:284) adds that participating in activism has a motive, which organises emotion and motivation.

Roth (2010)'s view which incorporates affective moments of learning that are inclusive of emotions is supported within the upheld Mathematics learning view. In their interaction Mathematics learners and teacher need to work together towards the attainment of the same ideal object of the activity and have to overcome some emotions to reach goal objectives. In the prevalent educational system in South Africa, teachers are held accountable and responsible for learner attainment of learning outcomes. The consistent grade 12 learners' underperformance bears repercussions on school principals and affected teachers. It is with reference to Mathematics teaching and learning but in concurrence with Roth (2012:95) that cultural-historical activity theory, which forces us to look at the entire system and study the changes therein, is maintained.

In addition, Even and Schwarz (2003:297) assert that activity theory views the structure of social interaction as source of the structure of human thinking. Therefore the teacher carries out actions aimed at helping the learners become involved, understand and develop a sense of shared ownership of the motive of the Mathematics activity as well as the goals of the actions. Thus during Mathematics lessons the following actions are to be carried out by the teacher (a) asking learners questions; (b) listening and responding to learners' questions, making remarks and suggestions; (c) assigning tasks for them to work on in small groups; and (d) trying to conduct whole group discussions. Hence the nature of social interaction in class must be conducive to encourage learner participation. This is in view of the fact that, amongst other factors, learners also have to deal with their own emotions to respond, actively listen, work on assigned tasks and contribute towards group discussions willingly. The degree of willingness is also determined by learner affect within the interaction.

Roth (2012:93), however, asserts that affect is a human factor that mediates cognition and forms an integral aspect of activity. Without affect there is no intentional movement and therefore, no activity or action. Affect may empower or disempower learners in relation to Mathematics. Empowering affect serves as an impetus to persevere, take risks, engage with new external and internal representations, ask questions or construct new heuristic plans (Debellis & Goldin, 2006:134). Moreover, proficiency in Mathematics is not an innate characteristic; it is achieved through persistence, effort, and practice on the part of learners and rigorous and effective instruction on the part of teachers (California Department of Education: 1999:6). However, Mathematics learner persistence and effort maintenance are realised through use of some volitional strategies. Hence cognitive use of volition strategies enhances the learning process.

2.2.2 The constructivist learning view in support of teaching approach

The encouraged use of affective construct volition strategies during Mathematics teaching is envisaged to take learning in directions that improve Mathematics learner engagement. This is in view of the fact that Mathematics learning is considered to be an active and constructive process. Mathematics learners need to assume control and agency over their own learning and problem-solving activities. De Corte *et al.* (2004:369) hint that active and constructive learning is an effortful and mindful process in which learnerslearner actively construct their knowledge and skills through reorganisation of their already acquired mental structures in interaction with the environment. But people invest more time and effort, feel less exhausted and are more persistent and more successful in pursuing goals perceived to be integrated in and supported by an individual's self-representational system (Sheldon & Elliot, 1998:546). In agreement, Orbell (2003:97) brings to light that the mechanisms of self-control lead to goal-maintenance which is the prime task of volition. Moreover, Orbell (2003:108) supports the claims of Kuhl (2000) and others (e.g. Bagozzi, 1992; Gollwitzer, 1993) that consideration of functional volitional processes enhances understanding of intentional behaviour. However according to constructivist view Mathematics learning is an intentional process that entails developing meaning through learners' own constructions. Hence execution and maintenance of use of learner volitional strategies need to constitute effective Mathematics learning.

With regard to formulation of meaning and to assist learners in assuming more responsibility for their own learning –which is a key aspect for higher performance in Mathematics–, consideration is given to some aspect of constructivism. The constructivist epistemology assumes that knowledge is actively constructed by the cognizing subject. Radical constructivists believe that Mathematics knowledge is not something that is acquired by listening to teachers or reading textbooks, but is something that learners themselves construct through actively seeking out and making, mental connections (Ellerton, 1992:4). This theory of knowledge considers that knowledge and knower are inter-connected. Therefore, knowledge about the world is subjective (Belbase, 2011:4). According to Draper as quoted by White-Clark, Dicarlo, and Gilchriest, (2008:41) constructivism is "the philosophy or belief, that learners create their own knowledge based on interactions with their environment including their interactions with other people". Constructivist theory also makes the claim that all mathematical ideas are grounded in human schemes of action. Mathematics is viewed as a result of personal constructions made through one's actions and reflections in those actions (Kelly & Lesh, 2000:238). To build one's world as a cognizing subject leaves one coordinating among actions, sensory impressions, inscriptions, discourse, and reflection, to weave together a mesh of sensibility, explanation and prediction (Confrey, 2011:178). Hence the prime focus of constructivist learning/teaching is engaging learners in productive thinking, analysing and synthesising of ideas through individual and social construction of knowledge (Belbase, 2011:17). This research argues for an active role for Mathematics learners that incorporate use of volitional strategies towards knowledge construction.

This research aims to highlight the contributive role of identified volitional strategies in Mathematics learning activity. This is with the intent to enhance use of some identified volitional strategies included in the designed volition self-management programme to improve grade 9 Mathematics learners' performance. It is believed that the approach will guide mindset to view Mathematics learning in a radical yet inclusive manner and help to build a comprehensive blueprint for restructuring Mathematics teaching to support both activity theory and constructivist instruction approach. Hence the combined learning view upheld in this research emanates from both activist and constructivist perspectives.

In the light of the preceding discussion the teaching and learning view maintained herein supports both activity theory and constructivism. Hence, in keeping up with Paul Ernest (1996:346), it is maintained that Mathematics teaching is to reflect the following:

1. Sensitivity toward and attentiveness to the learners' previous constructions. This includes using learners' previous conceptions, informal knowledge and previous knowledge to build upon.

2. Using cognitive conflict techniques to remedy misconceptions. This involves engaging learners in practices that allow them to trouble their own thinking with the intent that in conflict learners will develop their own meanings or at least seek to rectify the conflict.

3. Attention to meta-cognition and strategic self-regulation. This follows from the previous suggestion when learners think about their thinking and are willing to pursue their own learning.

4. Use of multiple representations. In Mathematics, multiple representations offer more avenues with which to connect to learners' previous conceptions.

5. Awareness of the importance of goals for the learner. This awareness of goals refers to the difference between teacher and learner goals and the need for learners to understand and value the intended goals.

6. Awareness of the importance of social contexts. Various types of knowledge occur in various social settings for instance informal (street) knowledge versus formal (school) knowledge.

Therefore the incorporation of volitional strategy use in Mathematics teaching and learning is intended to promote implementation of above mentioned activities. Hence it is believed that volition strategy use promotes Mathematics learner awareness of goals that in turn enhance their strategic self-regulation. Furthermore teacher awareness of the role of volitional strategies is envisaged to advance social context conducive to learning.

2.2.3 Learner disposition to school in rural communities in South Africa

The social contexts that prevail in rural communities pose learning problems. For example, the nature of learners' informal knowedge and inadequate previous knowledge to build upon new concepts. As a result learners are too depended on teachers and do not make use of adequate self-regulatory learning strategies. Some of the challenges that teaching in rural communities face involve motivating learners to learn intentionally, autonomously and effectively. The provision of education to ill equipped and demotivated learners for school engagement is problematic. Subsequently learner achievement levels in rural areas are usually low and there is a high rate of learner drop out of the school system. As well Mahlomaholo, (2012:101) observed that the problem of early school leaving seems to be compounded further when the learners reside and attend schools in rural settings of the country. Studies of educational exclusion make the same finding – that more out-of-school children are to be found in rural areas than are to be found in urban areas (Motala & Dieltiens, 2010:2). Furthermore, Motala and colleagues document that learners who fared less well in the Department of Education's national assessments of learning achievement for Grades 3 and 6 came from (in descending order) township, farm, rural and remote rural schools. (Motala, Dieltiens, Carrim, Kgobe, Moyo & Rembe, 2007:23). Still, more findings reveal that learners in rural schools perform worse than their counterparts in the urban areas (Motala *et al*. 2010:62).

In addition to the risk of dropping out, learners from rural communities face what has been referred to as 'silent exclusion' or lack of epistemic access. Epistemic access refers to access to suitable teaching, meaningful learning and adequate levels of achievement (Motala *et al*. 2007:57). Even Mahlomaholo (2012: 108) highlights that rural learners tend to experience high levels of early school leaving more frequently than their urban counterparts; and attributes it to how schools and curriculum provisioning by teachers exclude and marginalise them. As example, a particular problem in the South African context is that amongst those who are attending and enrolled there are those who learn very little and are silently excluded. The silent exclusion problem relates to both in-school factors such as poorly prepared educators, discrimination and lack of learner motivation and out-of-school factors such as poverty, hunger, illness and migration (Motala *et al*. 2010:105).

The environment in which schooling takes place is indeed a factor that limit learners' abilities to contend with schooling. More research from other countries has also shown that learners from rural backgrounds even face challenges succeeding in higher education (Czerniewicz & Brown, 2014:1). With regard to the success related challenges, the concept of habitus coined by

Czerniewicz and Brown (2014:4) fhat is widely used in education is herein included to consider how disadvantaged learners mediate their educational experiences. A habitus lens provides a way of showing learners' "ways of acting, feeling, thinking and being…how [they] carry [their] history, how [they] bring this history into [their] present circumstances, and how [they] then make choices to act in certain ways and then not others" (Maton, 2008:53). The habitus and use of capital is made in relation to the field of higher education. The embodied cultural capital refers to long-lasting dispositions of the mind and body, expressed commonly as skills, competencies, knowledge and representation of self-image (Czerniewicz & Brown, 2014:4). Hence the proposed research study is designed to identify learner ways of acting, feeling, thinking and being, and ways they are affected during successful volition implementation in rural community school.

Furthermore it is in this background of developing and understanding sustainable empowering learning environments and scholarship of engagement with a clear focus on quality learning for democratic citizenship in a socially just context. As well it is recorded that social justice paradigm advocate for universities to be inclusive and directly engaged in resolving problems of poverty, oppression and marginalisation as these impede optimal learning especially among rural and immigrant communities in South Africa, Canada and the world over (Mahlomaholo, Francis & Nkoane, 2010:281). Thus I concur with Mahlomaholo (2012: 107) that an adequate response to the problem of rural early school leaving seems to lie in the creation of sustainable learning environments.

In this section the upheld activity theory and constructivism concepts are used to explain how the entire system and instruction may promote learner understanding and teaching in meaningful ways. Use of volitional strategies is endorsed in view of the fact that the construction of meaning is an individual process, though there might be mediation of some social activities in such process. In the light of learner disposition to school in rural communities there is need for successful volition implementation to contribute towards sustainable learning environments. In the next section the role of volition mode of self-regulation is examined in order to understand practical implications in Mathematics learning.

2.3 THE CONCEPT OF VOLITION DEFINED AND ROLE IN RELATION TO MATHEMATICS LEARNING

Research has documented that volition is a system of psychological control processes that protect concentration and direct effort in the face of personal or environmental distractions and so aid learning and performance (Corno, 1993:16). In agreement Wolters (2003:194) emphasises that theoretical descriptions of volition portray it as encompassing both the regulation of cognition and the regulation of motivation, thus making it more analogous to the process of self-regulation. However there is difference that volitional perspectives on self-regulation emphasise the distinction between motivational processes or those that account for the selection of which goals to pursue, and volitional processes that are important for protecting the intention to pursue that goal (Kuhl, 1985; Corno, 2001; Wolters, 2003).

In this research study volition is defined as group of self-regulatory strategies to support explicit action tendencies against competing behavioural impulses during Mathematics learning (see section 1.2). Volitional processes can be applied consciously or it can be automatized as habits over time (Panadero & Alonso-Tapia, 2014:456).

2.3.1 The role of self-regulatory and effort management skills in Mathematics learning

In an attempt to contribute towards improvement of individual learner achievement, attention is paid to management and effort put in to sustain Mathematics learning. The management of learning involves employment of self-regulatory processes. Self-regulated learning theory states that when learners are given opportunities to self-regulate and explicitly taught about self-regulated learning strategies, academic achievement is more likely to be positively affected (Camahalan, 1998:194). An elaborate perspective on self-regulation held by Boekaerts and Corno (2005:201) is that self-regulated learners are engaged actively and constructively in a process of generating meaning and that they adapt their thoughts, feelings and actions as needed to affect their learning and motivation. In connection with learning of Mathematics, De Corte (1995:40) advocates for a dispositional view where learners' mathematical dispositions are manifested in ways they approach tasks, whether with confidence, willingness to explore alternatives, perseverance and interest and in their tendency to reflect on their own thinking. But other researchers conceive emotions and other affective processes as an integral part of problem solving and learning. Ongstad (2006:261) in particular asserts that:

> 'Doing Mathematics is a profound affective, emotional experience that implicates positive, negative as well as neutral aspects. Mathematics may be hated and loved; it is horrible and beautiful, clear and obscure, negatively frustrating and positively challenging'.

Incidentally, it is considered important that Mathematics teaching be broadened to extend beyond learning of concepts, procedures and their applications in order to alleviate maladaptive learning methods. Hence this research attempts to improve Mathematics learner achievement by paying attention to some variables believed to be linked to self-management and contributing towards application of effort to overcome challenges encountered in the process of learning Mathematics.

According to Kuhl (2000) activation of the self-system when pursuing a challenging task protects an on-going self-compatible intention from social demands or thoughts that are not self-compatible. The same thought is expressed by Orbell (2003:98) who highlights that during self-regulation the 'self as agent' maintains one's actions in line with the 'self' as defined by needs, emotional preferences, values and beliefs. While Sheldon and Elliot (1999:485) propose that whenever goals are perceived to be integrated in and supported by an individual's self-representational system, people invest more time and effort, feel less exhausted and are more persistent and more successful in pursuing those goals. The elements of self-regulation include managing and reducing high anxiety, using meta-cognition to monitor learning success, monitoring and regulating the use of effective and efficient learning strategies, managing time on a micro level (during a task, over a few hours, or day by day), focusing attention, and maintaining concentration over time (Weinstein *et al*. 2011:47). Hence in this regard there is need to incorporate self-regulation into the teaching and learning of Mathematics in order to remedy maladaptive learning methods that affect achievement. Thus in this study the role that certain self-regulation variables in the mode of volition play in predicting Mathematics achievement is investigated for learners in grade 9.

Thus the volition research pays attention to the mid-level in the hierarchy of regulatory systems where Mathematics learner actions are guided by emotions and coping systems. In particular the role of learner emotion control and other volitional strategies in regulating Mathematics learner actions to exert self-control over their cognition as they perform Mathematics tasks is of great concern. In accordance with Corno (2004:1671) it is emphasised that in school ''motivation can get learners started, but volition gets them to follow through''. Therefore to achieve the aim of the research the concept of volition is considered central to this study. As a matter of fact, Järvenoja and Järvelä (2005:467) even indicate that volition is needed when motivation and goal commitment are already established, but the learnerlearner must still sustain and support the decisions that have been made. In the middle school learning phase many learners develop negative self-motivational beliefs and struggle to deal with the academic demands for greater self-management. By ensuring implementation of volitional strategies middle-school learners can be empowered to exert greater control over their learning so that they become more upbeat, self-motivated learners. Thus the key issue of interest in this research is on Mathematics learners' use of volition mode of self-regulation in supporting learner motivation to initiate cognitive engagement which effects changes in study habits and ultimate achievement in Mathematics.

The view maintained by Zhu (2004:177) is that volitions are special kinds of mental actions by which an agent actively and mindfully bridges the gap between deliberation, decision and action. During the volition control phase learners monitor and control their behaviours, cognitions, motivations and emotions by enlisting strategies such as attention control, encoding control, self-instruction and attributions (Corno, 2001; Pape, Bell & Yetkin, 2003:182). In the same vein research by Orbell (2003:98) highlights that in the self-regulation mode of volition, an individual is able to identify and reject self-alien 'unwanted thoughts' or social demands which might otherwise interfere with goal-directed activity. It is hence upheld that volitions are mental activities by which Mathematics learners actively exert control over their thoughts in processes leading to and executing some Mathematics tasks.

There is, however, not much published research work on how volitional strategies facilitate the carrying out of Mathematics learner decisions about Mathematics tasks for South African learners. Hence this research investigates how use of some volitional strategies of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control and volitional self-efficacy protect the intention to learn Mathematics from competing action tendencies in order to improve learner performance. According to Boekaerts and Corno (2005:200) the system of self-regulation comprises of a complex, super-ordinate set of functions located at the junction of several fields of psychological research, including research on cognition, problem solving, decision making, meta-cognition, conceptual change, motivation, and volition. Therefore it is perceived that volition cannot be treated exclusively as it is a component of self-regulation. Hence the next section examines the concept of self-regulation necessary during Mathematics learning with intention to enhance cognitive engagement and achievement.

2.3.2 Practical implications of self-regulatory systems in Mathematics learning

Self-regulation during Mathematics learning implies that learners manage and monitor their own processes of knowledge building and skill acquisition. According to Ponton and Carr (2000:278) self-regulation entails supporting the task of maintaining one's action in line with one's integrated self. The more learners become self-regulated, the more they assume control and agency over their own learning; consequently they become less dependent on external instructional support for performing those regulatory activities (De Corte *et al*., 2004:369).

In view of the fact that documented research reveals that most self-regulation theories stress goal striving, there is need for self-regulation intervention to enhance goals pursuit as a result of specific learning problems encountered by middle school Mathematics learners. Some learning problems identified are reading disabilities, language impairment or low motivation, high anxiety, dysfunctional behaviour due to poor home conditions, peer pressure and inadequate teaching as enlisted by Boekaerts and Corno (2005:204). The effects of identified characteristics threaten the pursuit of learning goals during Mathematics learning. Hence envisaged implementation of volition mode of self-regulation strategies is with the intent to alter Mathematics learner work habits and ultimately improve Mathematics achievement.

From a social cognitive perspective Zimmerman (2000), Zimmerman and Kitsantas (1999), and Zimmerman and Schunk (2008) are in agreement about the three phases of self-regulation that are named as forethought phase, performance or volition control phase and self-reflection phase. Along this line of thought advanced by Zimmerman and other social psychologists, the research study intends to examine volitional aspects of self-regulation in grade 9 Mathematics learners in a community school situated in rural area. Figure 2.1 is a representation of aspects of volition mode of self-regulation.

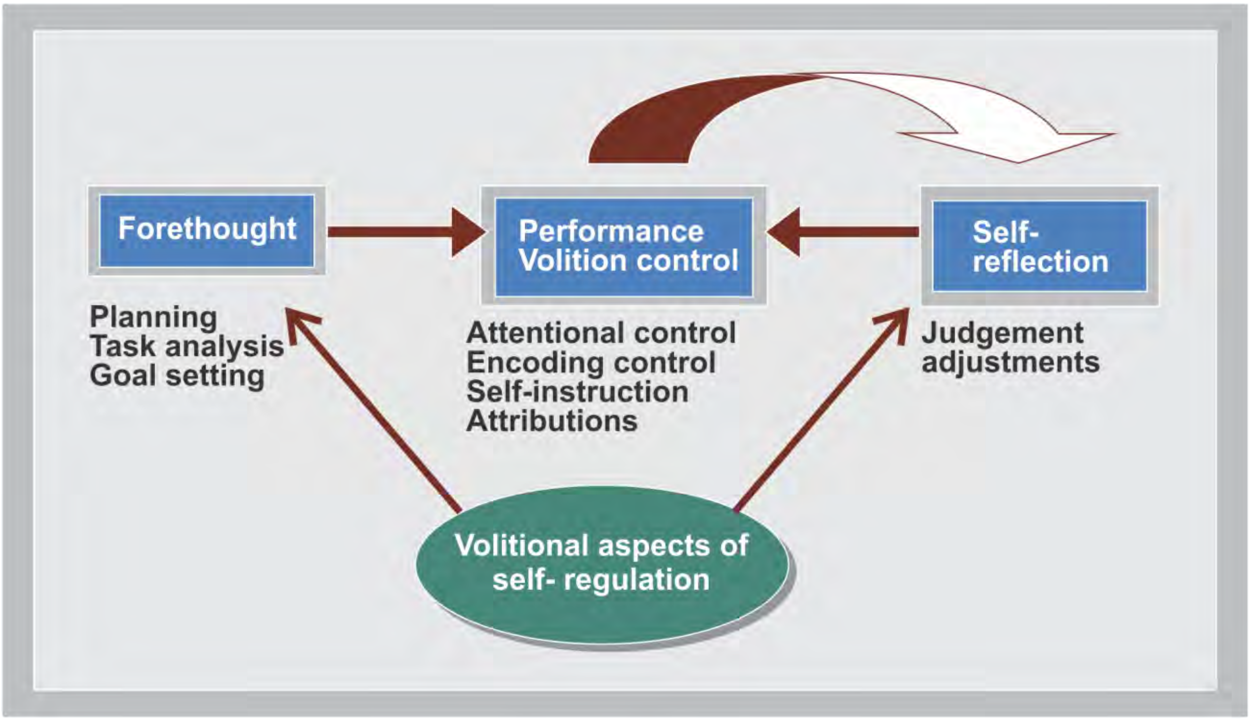


Figure 2.1 Volition aspects of self-regulation

In the forethought phase, self-regulated learners plan their behaviours by analysing tasks and setting goals. During the performance or volition control phase learners monitor and control their behaviours, cognitions, motivations and emotions by enlisting strategies such as attention control, encoding control, self-instruction and attributions (Corno, 2001:172). For example, self-regulation skills for regulating one's volitional processes or volitional self-regulation involves keeping up one's attention and motivation to solve a given problem, (De Corte, Verschaffel & Masui, 2004:369). In the final phase of self-reflection, learners make judgments of their progress and alter their behaviours accordingly (Pape, *et al*. 2003:182). The ability to report and discuss the experience of action is not simply a window on volition. Frith (2013:295) suggests that the explicit meta-cognitive abilities help learners to create their experience of agency and responsibility

When Mathematics learners apply the sub-function of self-monitoring during self-regulation especially after making comparison of current action with action needed in line with goal enactment they are encouraged to change inappropriate engagement. In the same manner learner self-judgement or self-reactions during Mathematics task stimulates them to alter study habits and to apply different learning strategies. Guided teacher instruction that encourages reflective practice enables teachers to determine possible reasons explaining effectiveness of used strategy. In the same manner learners self-reflect on increasing effectiveness of task related strategy used for, example using addition to check correctness of subtraction problems. Use of effective strategy enhances self-satisfaction and positive affect to continue improving their ways of learning. According to Schoenfeld and Kilpatrick (2008:31) stimulating reflection has additional advantage as it is an important mechanism for fostering knowledge construction. Therefore Mathematics learners are to be encouraged to engage in the sub-function of self-reflection that includes self-judgement and self-reaction made through learner adjustment.

2.3.3 Personality Systems Interaction theory as basis for volition

This volition research study is based on concepts assumed to be of central relevance to self-regulation which are taken from personality architecture and Personality Systems Interaction (PSI) theories. When the theories of personality architecture analyse the mental systems that shape the individual's enduring, distinctive patterns of experience and action, they pay close attention to cognitive and affective dynamics within the person (Kuhl, Kazén & Koole, 2006:409). According to Orbell (2003:97) PSI theory aims to extend on theory of planned behaviour by describing the conscious and non-conscious mechanisms which comprise volitional efficiency; that is, the functional processes that address how, *operationally*, behaviour is achieved. Earlier research by Kuhl and Kazen (1999:383) highlights the role of positive affect in modulating the interaction between intention memory and its output system (containing automatically available behavioural routines) in the theory of personality systems. A more expanded view on PSI theory as suggested by Kuhl *et al*. (2006:410), elaborates that human motivation and personality are mediated by a hierarchy of regulatory systems that can be summarised into three broad levels. At the lowest level behaviour is guided by elementary sensations and intuitive behaviour control that specialise in enactment of automatic behavioural programmes. At the mid-level behaviour is guided by emotion and coping systems that are distinguished into positive and negative affect systems, which regulate approach and avoidance behaviour. And, at the highest level, behaviour is regulated by complex cognitive systems specialised in sequential analytic processing and self-control on the one hand, or in parallel holistic processing and self-regulation, on the other hand.

2.3.4 The significant role of self-regulation in Mathematics learning

According to Turner and Husman (2008:143), learners' self-regulation for goal-striving incorporates goal-setting and goal-commitment with self-monitoring, self-evaluation, and self-reaction. It is believed that in the self-monitoring phase Mathematics learners direct cognitive attention to goal-relevant cues and compare current behaviour with behaviour needed for goal attainment. Secondly in the self-evaluation phase learners compare their performance against a standard or norm and adjust their learning activities depending on their informed perceptions of the quality of their work (Kitsantas, Reiser & Doster, 2004:270). Actually Kitsantas *et al*. (2004:270) add that self-evaluative judgments are not only closely linked to achievement outcomes but also to one's self-satisfaction and causal attributions. Zimmerman (2002:68) points out that attribution are important evaluative judgments because attributing errors to ineffective strategies sustains one's motivation in the face of difficulties, whereas attributing errors to ability discourages learners from exerting more effort on the task. And thirdly, in the self-reaction phase of self-regulation, two additional distinct classifications of self-satisfaction or dissatisfaction and self-efficacy expectations are proposed (Turner & Husman, 2008:143). Thus self-regulation during Mathematics learning involves learner actions of self-monitoring, self-evaluation and self-reactions in which learners are engaged in so as to adjust study habits in accordance with perceived progress towards goal attainment.

2.4 INTENTION AND MATHEMATICS PRACTICE

In Mathematics classes as well as in the external world, different goals compete for learners' attention. As a result the goal striving model on its own is inadequate to explain Mathematics learner self-regulated behaviour. What is more, the situation of competing goals creates a fragmented influence on learner behaviour, while the self-regulation model ignores interactions between achievement goals and other goals that learners pursue in Mathematics classrooms. Hence, under these circumstances it is significant, in accord with Cervone *et al*. (2006:336), that there be understanding of interaction among intrapersonal, interpersonal and socio-cultural factors that contribute to self-regulation during Mathematics learning. As an example: during Mathematics learning some goals adolescent learners pursue are both interpersonal and achievement goals like becoming a successful learner or earning approval from others. Boekaerts and Corno (2005:202) identify other goals of belonging, social support, safety, entertainment and self-determination that impact on learners. For this reason our attempts to understand Mathematics learners' persuasive response reactions incorporates the personality architecture theory.

The presence of other goals that Mathematics learners also pursue creates interference during goal striving. Hence in middle school, Mathematics learners at adolescent stage find it difficult to maintain intentions to accomplish learning goals. By drawing attention to the distinction between goal and intention, we aim to contribute towards understanding reasons behind non-accomplishment of Mathematics learning goals. The generally accepted view is that the term goal refers to intended outcomes. According to Kuhl and Kazen (1999:382), an intention is defined as an action plan held in an active state, whereas a goal is a representation of an outcome of an intended action that may be part of a plan. Hence it is purported that the challenge to mathematics learners is how to formulate and adhere to action plans after intentions are formed. Adams (2006:258) denotes intentions as the mental states that represent our purposes. Thus the learners' intention to perform the act of Mathematics practice outlined in their homework plan is the predictor of Mathematics learning goal enactment. Mathematics learners with stable mind are purposeful and remain with their intentions till accomplishment. But reasoned action plan is under the learners' voluntary control and has limitations. Notwithstanding their strong intentions to do Mathematics homework, learners may still not perform activity because of lack of ability or other external constraints. Above all the temporal stability of an intention, an important aspect of its strength, moderates the relation between intentions and behaviour such that relatively stable intentions predict behaviour better than do relatively unstable intentions (Trafimow, Sheeran, Conner & Finlay, 2002:116).

However, intentions serve a role in guiding and monitoring the execution of intentional action (Zhu, 2004:180). In concurrence, Vermeer, Boekaerts and Seegers (2001:313) found that learners' willingness to maintain learning intentions and persist toward mastery in the face of difficulty depends on their awareness of and access to volitional strategies (i.e. meta-cognitive knowledge to interpret strategy failure and knowledge of how to buckle down to work). Hence in this construct, but also in line with thinking by Kuo and Young (2008:1225), an intention is considered the degree to which learners are willing to try or how much of an effort they are planning to exert to perform some Mathematics task. Subsequently intentions serve as cognitive processes that seem essential in transforming what Mathematics learners want to do into what they actually do. Hence social psychological concepts of volition are related to the functional neuroanatomy of intentional action (Brass; Lynn; Demanet & Rigoni, 2013:301)

In addition, still according to the theory of reasoned action, intentions to perform some behaviour are determined by attitudes towards the behaviour and subjective norms. Attitudes towards Mathematics would refer to learners' positive or negative evaluation of their performing the Mathematics tasks, for example, "Doing Mathematics homework would be wise/foolish". Subjective norms refer to learners' perceptions of approval or disapproval from significant others for performing the task, for example, "Most people who are important to me think that I should do my Mathematics homework". According to the theory of reasoned action, attitudes play a dominant role in translating intentions into action during Mathematics learning. But the viewpoint sustained in line with PSI theory attributes the maintenance of intentions to the extent to which self-regulatory volitional components are mobilised in the pursuit of the goal (Orbell, 2003:99). In this regard learner use of volitional mode of self-regulation of intention monitoring is likely to significantly impact towards the goal of improving Mathematics achievement.

Mathematics learners also select learning goals they wish to pursue through various motivational processes, but need to employ implementation intention strategies to work towards achievement of chosen goals. Along these lines volitional perspectives on self-regulation emphasise the distinction between processes that account for the selection of which goals to pursue and volitional processes that are important for protecting the intention to pursue that goal (Corno, 2001; Kuhl, 1985, Wolters, 2003:194). According to Gollwitzer and Schaal (1998:124) implementation intentions are acts of will established at levels of operative planning and execution of tactics during action control. Forming an implementation intention basically involves setting up an "if-then" production statement whereby actions are automatically triggered when appropriate situational cues are encountered (Diefendorff & Lord, 2003: 368). The format of implementation intention condition may be:

> ”In process of working out Mathematics problems when I encounter distraction, I will just ignore” or
>
> ”If it is Wednesday at 18h00 I will perform as many mathematics tasks as possible”.

The conscious act of will delegates the control of one's actions to anticipated inner or external events to induce direct automatic action control. Hence Oettingen, Honig and Gollwitzer (2000:707) assert that additional elective volitional strategies have been identified that bring about strategic automation of action initiation through implementation intentions.

Other researchers as well, Gollwitzer and Brandstatter (1997); Orbell, Hodgkins and Sheeran (1997); Sheeran and Orbell (1999); and Sheeran and Orbell (2000:535) agree that implementation intentions moderate relationships between intentions and planned behaviour. Therefore implementation intentions enable learners to determine whether they remember at appropriate times what is to be done, for example, which Mathematics tasks are to be completed at a particular time.

Implementation intentions are important components of meta-cognitive control of action geared towards initiation, continuation and termination (Gollwitzer & Schaal, 1998:124). Moreover, Oettingen *et al*. (2000:722) indicate that forming implementation intentions is a powerful self-regulatory tool for overcoming problems of getting started with goal-directed actions, especially when learners are tired, absorbed with some other activity, or lost in thoughts, and thus miss good opportunities to act. Furthermore Oettingen *et al*., (2000:722) also observe that learning goals difficult to reach benefit greatly when learners provide implementation intentions. Therefore increased learner awareness with regard to engaging in volitional implementation intentions strategy use is expected to boost Mathematics learner performance.

Mathematics learners who are trained to monitor their goal intentions carry out Mathematics processes without difficulty as they put more effort into strategy use. Implementation intentions prompt learners to exert pressure and work towards timely completion of Mathematics tasks as planned. Thus forming implementation intentions transfers the control of goal directed behaviour to specify anticipated environmental stimuli (Gollwitzer & Schaal, 1998:134). Hence, effective self-regulation during learning of Mathematics planning is to be used in conjunction with self-evaluation to assess progress.

This section, the importance for learners as agents in self-management to exert effort so as to overcome challenges in the process of learning Mathematics, was examined first. Secondly, the need to use volitional mode of self-regulation in controlling learner cognitive actions to effect changes in study habits and ultimate achievement in Mathematics was considered. Thirdly, the structural model of self-regulation and its importance during learning of Mathematics was scrutinised and the significant role of establishing learner intentions during Mathematics practice was highlighted. In the next section we explore the volition mode of self-regulation in pre-action phase as exhibited by strategies of planning and initiating during Mathematics learning. Hence I emphasise the role of mode of volition control that bring about self-regulation by encouraging use of Mathematics learner self-efficacy.

2.5 VOLITION MODE OF SELF-REGULATION IN PRE-ACTION PHASE

Some authors who advocate for action control have called for greater attention to the distinction between forming a decision (an intention), primarily a motivational process, and implementing it, a volitional process (Kuhl & Fuhrmann (1998); Zhu (2004); Kuhl, Kazén & Koole, (2006)). The process of making a decision for a goal and against competing goals is motivational. while a volitional process is one of maintaining and enhancing the commitment to a goal that one has decided for so that it can be put into action (Heckhausen, 2007:166). In section 2.2 volition is defined as an array of self-regulatory strategies to support explicit action tendencies against competing behavioural impulses (Kehr, 2004:485). The conceptual framework for volition and its role in human action regulation is a sequential model of action phases organised around the decisional Rubicon. According to Heckhausen (2007:166) crossing the Rubicon means to make a decision that has irrevocable consequences. Once the decision about a goal intention has been made, the decisional Rubicon is crossed and the next phase is post-decisional yet pre-actional. This phase is functionally dedicated to planning the action when action has to be delayed due to not-yet-present opportunities or other urgent activities (see Figure 2.2).

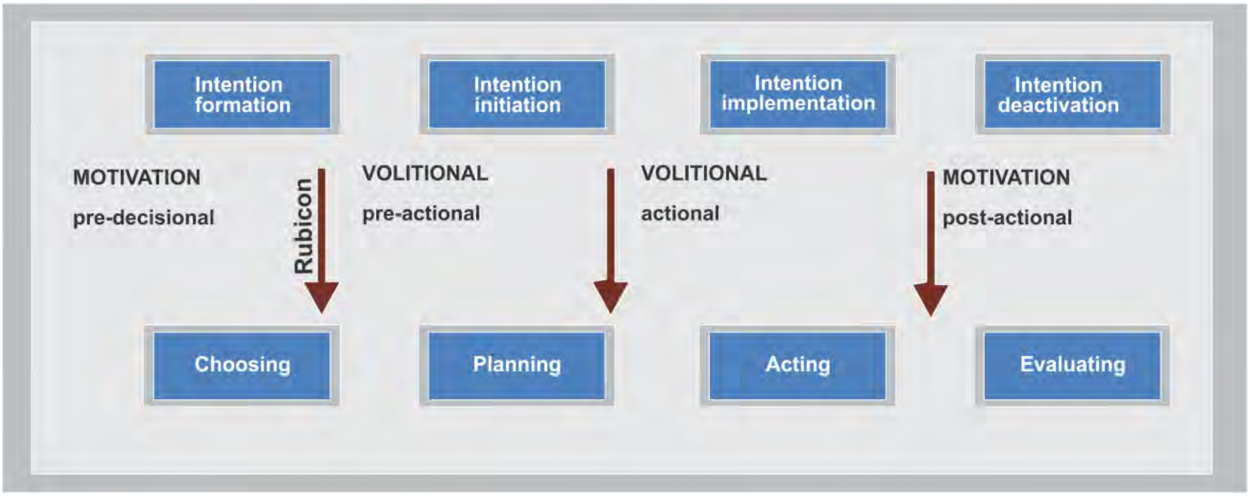


Figure 2.2. The Rubicon model of Action Phases (adapted from H. Heckhausen & Gollwitzer, 1987).

A volitional commitment that is binding and specific enough to help the Mathematics learner to start the relevant action and carry it through to goal attainment is needed after a decision for a goal has been formed. Volitional regulation suppresses unwanted implicit behavioural impulses; for example, avoiding wandering thoughts when one intends to work on Mathematics at hand (Kehr, 2004:485). Hence the action phase model is based on the conceptual distinction between motivational issue of goal setting and the volitional (wilful) issue of goal striving. Also the model provides a temporal perspectives that starts with awakening of peoples' wishes prior to goal setting and continues to the evaluative thoughts people have once goal striving has led to some outcome. The sequence of events within this comprehensive time frame is spelt out in four successive, discrete tasks that need to be accomplished in order to promote wish fulfilment (Gollwitzer, 1996:289).

The first of the tasks to be accomplished in the pre-decisional phase consists of deliberating on wishes and setting preferences during Mathematics learning. The goal initiation stage intended to help learners perceive the value of the mathematics course and desire to get something out of the course (Kim & Bennekin, 2013:794). Learners decide which of their many wishes they prefer to pursue. Preferences are established by employing the evaluative criteria of feasibility and desirability. Feasibility is determined by reflecting on Mathematics self-efficacy. The model further suggests that desirability relates to the expected value of wish fulfilment that indicates anticipated positive or negative self-evaluation, evaluation through others, excitement of acting on the wish and external costs or rewards. Hence, according to the action phase model, Mathematics learner preferences are established when they self-evaluate and reflect on their self-efficacy to achieve desired goals.

2.5.1 Volitional Self-efficacy and the Mathematics learner

The Social Cognitive theory interprets human functioning as a series of reciprocal interactions between personal influences of thoughts, beliefs, environmental features, and behaviours (Schunk, 2007:8). But Ignacio, Nieto and Barona (2006:27) emphasise the effect of beliefs on performance in demonstrating the belief that dedication and effort are essential factors in achieving success in Mathematics. Self-efficacy is the belief in one's capability to organise and perform a set of activities necessary to complete a task at a specified level of competency (Bandura, 1986, 1997, Ramdass & Zimmerman, 2008:20). But as documented by Butler and Winne (1995:256) self-efficacy is emphasised as motivational beliefs involved in self-regulation.

In the theory of planned behaviour self-efficacy is considered an additional predictor of intentions with perceived learner behavioural control. The learner appraisals of own ability to perform Mathematics tasks and beliefs that action is under one's self-control determine how far they progress. The ways in which learners participate in Mathematics activities are influenced by the views of themselves as members of the Mathematics community and their individual ways of knowing. According to Ramdass and Zimmerman (2008:37), unrealistically low self-efficacy beliefs and not lack of ability or skill may be responsible for avoidance of challenging academic courses such as Mathematics. Research as documented by Stevens, Harris, Aguirre-Munoz and Cobb (2009:904), has consistently revealed strong positive correlations between learners' self-efficacy and subsequent academic performance, especially Mathematics performance.

While some learners in Mathematics classes when coming to assigned tasks hold the perception that they are useless. On the other hand learners with a conception of volition regard themselves as 'being in control' (Brass *et al*. 2013:302). The learners who consider themselves as being incapable and not having what it takes to succeed in Mathematics do not want to struggle long. For example, a learner may have an intention to perform some Mathematics task on the chalkboard in class, yet his or her actions may be impeded by uncertainty about peers' reaction, or fear of failure. But self-efficacy belief prompts and the amount of explicit verbalisation needed while learners are solving problems may bring back confidence to implement intention of attempting Mathematics task at hand. The belief prompts exemplified in self talk are volitional and are involved in action control.

Such learners when assigned tasks fill their minds with negative thoughts like 'It would be difficult for me to do Maths homework and will ultimately not even attempt the homework. Yet other learners persist long as they fill their minds with thoughts of certainty that 'it will all come out all right in the end'. Persistent learners are comfortable with culture of Mathematics practice. By the way, Turner and Husman (2008:144) point to these self-efficacy expectations as self-reactions about judging one's capabilities of moving forward, organising and executing behaviours that will lead to goal attainment in the future. Kuo and Young (2008:1233) concur and stress that one's action/state orientation moderates his or her enactment of subjective norms and self-efficacy beliefs into intentions, and his or her enactment of controllability into behaviours. Indeed learners who are satisfied with their performance report high self-efficacy beliefs and encourage themselves to persist in their efforts to continue to work diligently (Kitsantas *et al*., 2004:285).

Mcleod (1992:581) highlighted that beliefs provide an important part of context within which emotional responses to Mathematics develop. Specifically Navarro, Flores and Worthington (2007:330) record that math/science self-efficacy is belief influence that positively predicts math/science outcome expectations, as both of these variables positively predict math/science interests and goals. In self-regulated learning, self-efficacy influences the goals a learner sets, commitment to those goals, decision making at branch points along a path the learner constructs to reach those goals, and persistence (Bandura, 1993; Butler & Winne, 1995:256). The view held by De Corte *et al*. (2004:370) even includes self-efficacy beliefs among aptitudes such as prior knowledge, conceptions of learning, learning styles and strategies, interest, motivation, and emotions that affect learning. Therefore to generate productive Mathematics teaching, learner instruction should take into account aptitude of volitional self-efficacy.

Moreover, in keeping with Oettingen *et al*. (2000:718), it is envisaged that when expectations of success are high, binding goal commitments lead to increased effort and high Mathematics performance emerge. Stevens *et al*., (2009:904) concur as they postulate that self-efficacy forms through four primary sources, mastery, persuasion, vicarious experiences and physiological states and relates to more accurate estimates of one's abilities. Even Kloosterman and Stage (1992:111) indicate that Mathematics learners' beliefs about themselves especially beliefs in the possibility of increasing their own mathematics ability by working hard and believing in the usefulness of mathematics in everyday life, have all assumed to be related to the motivation to learn to solve Mathematics problems. These motivational beliefs affect learnerlearners' emotional and affective responses in the various mathematical situations (McLeod, 1992:579). Indeed, Miller and Brickman, (2004:12) also add that self-perceptions of efficacy influence both initiation and continuation of goal pursuit. On the other hand, Butler and Winne (1995:263) propose that feedback that supports learners' construction of positive motivational beliefs and/or use of action control strategies may support engagement in self-regulation. Moreover, research by Malmivuori (2006:161) specifies that high self-efficacy and positive affective responses are positively linked to pro-motive self-regulatory patterns of persistence and preference for challenge in Mathematics. Higher self-efficacy and use of task strategies promote learner's division skill (Schunk & Gunn,1986:238). Hence it is proposed, in agreement with Eccles and Wigfield (2002:111) that Mathematics' learner efficacy expectations are to be among the major determinants of goal setting, active choice, willingness to expend effort, and persistence.

Stevensa *et al*. (2009:904) are of the view that self-efficacy beliefs tend to be a better predictor of performance. This is due to fact that research questions on self-efficacy are concerned with capabilities to execute specific tasks or courses of action, even though their outcomes may or may not have any bearing on self-esteem. Learners who are satisfied with their performance report high self-efficacy beliefs and encourage themselves to persist in their efforts to continue to work diligently (Kitsantas *et al*., 2004:285). Mathematics learner self-efficacy is supported by using self-talk approach or avoidance, as in reminding one's self of past successes or thinking about the outcomes of potential failure.

The on-going Mathematics learner processes of self-observation, self-judgment, and self-reaction are components of self-regulation that affect continued goal pursuit. On the other hand Liu and Yan (2003:36) identify self-efficacy as one of the main factors that are associated with stress. Hence it is necessary to train Mathematics learners to raise their self-efficacy and improve their attribution pattern in order to reduce the negative impact of stress. More literature provides evidence that specific measure of action control on physical activity has been shown to mediate fully the influence of behavioural intentions and to mediate partly the influence of other more distal volitional measures, such as action planning and volitional self-efficacy (Sniehotta, Nagy, Scholz & Schwarzer, 2006:103). As suggested by Ramdass and Zimmerman (2011:204), it is envisaged that volition enhancement training can be successfully implemented in the elementary classrooms during homework activities to help learners develop self-efficacy, and self-reflect on their Mathematics performance. In this regard, how then would instruction that entails volition enhancement impact on the measure of volitional self-efficacy formed during Mathematics learning?

To sum up: this section highlighted documented evidence in support of the significant role of self-perceptions of learner self-efficacy during Mathematics learning. The evidence includes observation of strong correlation between learner self-efficacy and subsequent Mathematics performance, also of self-efficacy belief influence in both initiation and continuation of goal pursuit. The next section examines the role of volition in assisting learners to overcome the problem of getting started on Mathematics tasks through planning and initiating of activities.

2.5.2 Volitional function of planning and action initiation during Mathematics learning

Mathematics learning is viewed as an active and constructive process that is effort demanding. During the process of learning, Mathematics learners actively construct their own knowledge and skills through reorganisation of their already developed mental structures in interaction with the environment (De Corte *et al*., 2004:369). Mathematics learning is regulated by control and awareness of cognitive processes that develop concurrently with an understanding of mathematical concepts (Schoenfeld, 1992:66). In order to enhance acquisition of basic Mathematics concepts and computational skills, educators develop and assign tasks to learners. However, the assignment tasks are of little use unless learners choose to engage in the assigned work (Cates & Skinner, 2000, Wildmon *et al*, 2004:107). Therefore Mathematics learners need to deliberate on tasks they wish to accomplish and set preferences and plan how tasks will be approached. Volition control through setting of plan(s) for engaging in identified task generates criteria against which successive states of engagement can be monitored.

The volitional function of planning is explained within the framework of motivational - volitional theory of goal attainment using the model of action phase (Gollwitzer, 1990 & 1996:288). The first of the tasks to be accomplished in the pre-decisional phase comprises deliberating on wishes and setting preferences during Mathematics learning. Learners decide which of their many wishes they prefer to pursue (section 2.5 has reference).

The second phase in action model is referred to as pre-actional. The phase deals with progress learners make towards fulfilling a wish and demands a decision to act on a given wish. The model speaks of transition from wishes and desires to binding goals that are accompanied by obligation to fulfil the implied wish. Forming a goal commitment is a prerequisite towards wish fulfilment. After initiation of goal directed behaviour according to the model, individuals enter the third phase called the actional phase. The task associated with the actional phase is bringing goal directed behaviour to a successful conclusion. To advance further on the way from wishes to action, Mathematics learners are to reflect and decide on when, where, how and how long to act, and in so doing elaborate on plans for action. Mathematics learners are to act on opportunities that allow progress toward goals and when difficulties and hindrances are encountered, they increase their effort (Gollwitzer, 1996:290).

The final stage in action phase according to the model is the “post-actional” phase. Here the task is to evaluate goal achievement by comparing what has been achieved to what was desired as reflected in the plan for action.

Indeed according to Byman and Kansanen (2008:615), Mathematics learning situations demand volition and studying. Mathematics learners make use of volitional strategies during transition from wishes and desires to binding goals through plans. Even Turner and Husman (2008:165) contend that, through invoking volitional strategies, learners initiate or maintain learning activities and therefore become actively engaged for learning.

For example, when learners opt to be cognitively engaged in enactment of assigned Mathematics tasks, it is necessary that they develop plans with clear learning goals. Then, subsequent to goal formation, follows prompt initiation and execution of successful goal-directed actions. In particular, working towards attainment of Mathematics learning goals embrace wilful learner selection of appropriate keywords and correct application of rules to be used in reasoning about problems. Hence wilful learner selection of recognised keywords, correct Mathematics sign or symbol usage and applied effort are needed for Mathematics content reorganisation.

According to Gollwitzer (1996:302), planning orientates learners towards issues of implementation. The successful Mathematics content reorganisation is facilitated by transition from identified learner goals through a process of planning and voluntary initiation of cognitive activities in or outside class lessons. Moreover, Kim and Keller (2010:410) mention planning and making a commitment to the goal as strategies that can help learners take action towards achievement of learning goals. Nonetheless, in some Mathematics classes learners encounter volitional problems getting started on assigned tasks. Learners in pursuit of the outcome to reorganise Mathematics content who are not accustomed to planning, find it difficult to process information. In this current study, Mathematics learner goals that do not reflect any planning but merely refer to an outcome are classified as goal intentions. But Mathematics learning goals that are planned are referred to as implementation intentions. Therefore the planning process reflects transition from goal intentions to implementation intentions. The continued application of planning by both teacher and learner contributes towards Mathematics knowledge construction.

Furthermore, after some break in teaching lesson, learners encounter problems of getting started with goal-striving action of doing homework and staying on track. But committed and successful Mathematics learners overcome this volitional problem of getting started on tasks by indicating their intended plans of action beforehand. In agreement Gollwitzer, Gawrilow and Oettingen (2010:279) advise making "if and then plans" for alternative learner reaction response facilitates solving the crucial problems of goal implementation. When learners adhere to plans, Diefendorff and Lord (2003:366) assert that it has volitional benefits of helping learners overcome problems of action by persisting despite difficulties and completing tasks faster. Gollwitzer (1996:307) also contends that planning helps learners to mobilise effort in the face of difficulties and to ward off distractions. In addition successful Mathematics learners go beyond forming learning intentions and overcome mere desire to act, but are persistent in working on their planned tasks in spite of any difficulties encountered. Thus for learners in pursuit of understanding and success in Mathematics learning, individual planning is instrumental for continued goal-striving action.

Planning is defined as the process of generating a sequence of behaviours used to translate an individual's resources into actions aimed at goal attainment (Austin & Vancouver, 1996:340; Diefendorff & Lord, 2003: 367). As examples during Mathematics learning practice, learners' wilful target acts of implementation such as obligation to explain and justify answers are sequences of behaviours that are translated into actions. The target acts constitute an inquiry-oriented classroom culture. Planning based on repeated reproduction of these wilful target acts of implementation encourages powerful mathematical minds. In Mathematics class during inquiry-oriented learning plans reveal how learners justify pattern detection and rule establishment that are target actions needed to attain goal during problem solving. Thus if the implementation of a chosen method does not lead to expected answers, learners make a further decision to try alternate methods. Planning that reflects learner ways to explain and justify answers should influence Mathematics content re-organisation. Hence planning based on forming wilful acts of implementation intentions possesses the potential of inducing strong implemental mind-sets (Gollwitzer, 1996:308).

Keller (2008:41) defines volition as a transforming desire to action. Mathematics learners committed to taking responsibility over the process of own knowledge acquisition advance in Mathematics as they work on their assigned tasks despite distractions. In agreement to

Gollwitzer (1996:290) such individual learners reflect and decide on when, where, how, and how long to act as they create plans for action. Hence it is put forward that during Mathematics class activity learners who choose to re-examine the example as worked by teacher or in the text book, then decide to sit and work on other related problems are volitionally in control of their own learning. De Corte *et al*. (2000:683) highlight that learners who assume control and agency over their own learning as well as problem-solving activities are self-regulated. This implies that successful Mathematics learners manipulate and direct their own behavioural actions to achieve desired learning goals. Therefore unrelenting goal setting and planning during Mathematics should enhance self-regulation.

Furthermore, Gollwitzer (1996:293) documents that planning and commitments to learning goals are components that correspond with the sub-concept of implementation intentions. Heckhausen, Gollwitzer and Steller (1990:1119) have drawn a distinction between a decision-making phase of goal-directed behaviour, during which the costs and benefits of behaviour are evaluated and which culminates in the decision to act and a volitional phase characterised by the formation of action plans referred to as implementation intentions coined as implemental mind-set. Zimmerman (2002:68) proposes that in the forethought phase self-regulated learners actively plan their behaviours by analysing tasks and setting goals. Pape *et al*. (2003:182) conclude that the learning phase characterised by plans to initiate the behaviour at a specific time and place is volitional. Even so, implementation intentions spell out plans that link situational prompts to goal directed behaviour. For example, Mathematics learners need to specify when, where and how they intend doing their homework. Therefore, for effective goal implementation and accomplishment of procedural learning skills detailed planning, outlining cues is necessary. Therefore planning is the foremost aspect of Mathematics learning process that precedes effective learning. Thus determined Mathematics learners need to have a transforming desire to be engaged in constant planning, setting goals and committing to goal attainment. Planning in Mathematics facilitates a process of how learners assume control over their own learning and acquisition of procedural learning skills.

In view of the fact that the procedural processes that guide learner acquisition of Mathematics concepts involve investigative or exploratory teaching approach. Debellis and Goldin (2006:132) also mention that learner acquisition of Mathematics concepts is facilitated by meta-cognitive control processes which include planning. Learners need to volitionally perform planned and sequential cognitive actions to enhance understanding of Mathematics concepts.

Furthermore, Gollwitzer (1996:304) mentions that planning creates a certain closed mindedness based on a narrow field of attention. Dienfendorff and Lord (2003:366) reiterate that planning has volitional benefits which lead to increased learner persistence and confidence. Planned Mathematics practices build learner confidence in the execution of processes involved in problem solving. Indeed, a more inclusive view on volition benefits, according to Gollwitzer's (1996:293) theory and empirical work, embraces protecting active intentions from interference from competing intentions, bolstering one's confidence, preventing distractions, and increasing the likelihood of timely and appropriate initiation of goal-directed activities. Therefore in Mathematics teaching and learning, plans are to be encouraged in order to restrict learner attentiveness and protect against distractions.

A more comprehensive view includes planning and executive control, governing heuristic and strategic decisions together with an affective system, involving emotions, attitudes, beliefs, morals, values and ethics within a model for Mathematics problem-solving competency.

To sum up: planning the process during Mathematics teaching and learning is of significant importance as it enables learners to overcome the volitional problem of getting started on assigned tasks. Planning promotes dynamic interaction of Mathematics concepts and meta-cognitive processes during Mathematics investigations. Planning also supports learner transition from goal intentions to implementation intentions. In the next section we examine how the volitional control phase is endorsed by Mathematics learners in goal pursuit through intention monitoring.

2.6 VOLITION CONTROL PHASE DURING MATHEMATICS LEARNING

2.6.1 Intention monitoring

Constructivist theory makes the claim that all mathematical ideas are grounded in human schemes of action. The construction of knowledge largely relies on learners' personal activity in the environment learners are situated. Mathematics is viewed to emanate from personal constructions made through one's actions and reflections in those actions (Kelly & Lesh, 2000:238). Even Schoenfeld and Kilpatrick (2008:18) highlight that the social, mathematical and socio mathematical norms that are constructed and enforced, are a result of the personal relationships engendered and discourse patterns in classrooms. Hence it is maintained in step that the social norms include interaction where learners maintain their Mathematics goal intentions as they discuss and argue about Mathematics concepts freely without fear of open criticism. In this regard the term goal refers to Mathematics learners' intended outcomes while an intention is defined as a learner's action plan that is held in an active state. Hence a goal as a representation of an outcome of an intended action may be part of a plan (Kuhl & Kazen, 1999:382). In particular the mathematical norms involve a teaching style of introducing concepts during Mathematics practice in ways that are interesting and support learner goal intentions. For this reason the learning environment designed to foster interactions that support thriving Mathematics communities takes account of individuals' maintenance of learner goal intentions and conducive social context.

In addition, the view consistent with Cobb, Steyn, McClain and Gravemeijer (2001:121), attributes mental activity and intelligence to intention monitoring, control of thinking and control of emotions demonstrated by individual learners' reasoning ability. However, the learning phase model focuses on goal commitment and postulates that progress towards goal attainment first of all requires a decision that transforms the deliberated wish or desire into a binding goal that ends conflict among competing wishes or desires. Such a decision takes the format "I intend to achieve the solution of" and therefore is best conceived of as a goal intention (Gollwitzer, 1996:292). To develop a full goal commitment, like to form the intention to achieve higher in Mathematics, a further relevance check is made of how learners willingly take control of making use of available time and opportunities to work on assigned tasks or execute problem solving skills. Hence it is acknowledged that the Mathematics learning process is driven by continued mental activity made up of volitional cognitive prompts that include elements of monitoring and control. .

Reference to PSI theory which is basis for reasoning distinguishes two main forms of complex self-government, viz. goal enactment and self-development. Goal enactment involves an interaction between intention memory, which forms and maintains abstract goal representations, and intuitive behaviour control, to translate abstract goals into concrete actions (Kuhl *et al.*, 2006:411). But volition controls intentions and impulses, so that the expected action of studying occurs (Byman and Kansanen 2008:607). The opinion herein maintained is that intention monitoring involves the psychological mechanism by which a learner actively and mindfully bridges the gap between an intention and action. A more inclusive view by Wolters and Rosenthal (2000:817) documents that learner use of intention monitoring serves as one mechanism through which attitudes translate into greater effort and persistence at Mathematics tasks. In support, Mele's (2007:741) account considers intentions as executive attitudes toward plans.

Mathematics learner intentions also signify effort concentration displayed by learners with the objective of performing Mathematics procedural skills. The link between Mathematics learner goal intentions and classroom social context is instrumental in maintenance of effort to support a fostering of Mathematics process skills. Herein, in line with Perugini and Conner (2000:708) who considers intention as an expression of commitment and of effort, it is upheld that Mathematics learning goal intention is effort needed to enact some mathematical practice. Thus intentions indicate the extent to which learners are willing to continue working on assigned tasks or how much of an effort they are planning to exert to perform the Mathematics task. Learner decisions based on planning dictate effort to be applied and duration of time spent. Zhu (2004:180) elaborates that intentions are states of mind that initiate, persist throughout time and guide action. Therefore, for Mathematics learners to uphold their learning intention they need to set a learning goal, devise a plan of action and then provide their own standard for determining error and correction or damage control when the plan goes wrong. Hence in this study Mathematics goal intentions also denote effort concentration displayed by learners with the objective of performing Mathematics procedural skills. Intention monitoring has some significant role in advent of correcting slack Mathematics learner performance.

Additionally, Kuo and Young (2008:1225) reiterate that intention refers to the degree to which learners are willing to try or how much of an effort they are planning to exert to perform some task. Intention monitoring strategy applied during Mathematics learning enables learners to determine whether they remember at appropriate times what is to be done, for example, which Mathematics tasks are to be completed at a particular time. In recognition that unwanted attention responses, unwanted behaviours, and unwanted thoughts and feelings can each drive goal striving off track and prevent Mathematics learners from reaching their goals, there is need to include awareness of volitional strategy of intention monitoring and contributing role towards learner maintenance of effort to work towards desired Mathematics goal.

Effective intention monitoring even entails Mathematics learner awareness of set standards. The implication is that the learner develops a clear strategy, commits to using the strategy under specific conditions and undergoes self-monitoring. Also the learner incorporates self-evaluation to maintain self-regulatory effort while studying Mathematics. Boekaerts and Corno (2005:206) found that learners' willingness to maintain learning intentions and persist toward mastery in the face of difficulty depends on their awareness of and access to volitional strategies (i.e. meta-cognitive knowledge to interpret strategy failure and knowledge of how to buckle down to work). As learners are skilled to monitor their intentions, the carrying out of Mathematics processes is assisted by effort spent while learners concentrate on strategy use. When taking account of the fact that Mathematics learning processes are driven by continued mental activity made up of cognitive prompts that include elements of monitoring and control, it is assumed that intention monitoring will facilitate individual learners to exert pressure and work towards timely completion of Mathematics tasks.

The view herein endorsed is that volitional strategy of intention monitoring interacts with emotions to influence maintenance of intentions for learners to apply the necessary effort to work towards the end of Mathematics problems. The enthusiasm and choice to work towards objectives of Mathematics tasks is further determined by present and future learning intentions. The intentions are maintained subsequent to the value individual learners attach to Mathematics as a learning subject. Hence Mathematics learners are to be vigilant in monitoring their own intentions and knowing how to make a choice to control any negative emotions as they progress towards the attainment of expected future goals.

In this section goal intentions are associated with the instructions that Mathematics learners give themselves to perform particular Mathematics tasks and achieve desired outcomes. The significant role of intention monitoring to assess goal progress promotes Mathematics learners' volitional competency. The next section examines how the volitional control phase is facilitated by Mathematics learners through attention control.

2.6.2 Attention control

The volition strategy of attention control forms part of a self-system which learners use when pursuing a challenging Mathematics task. The strategy protects an on-going self-compatible intention from social demands or thoughts that are not self-compatible. This self-regulatory strategy of attention control informs how individual Mathematics learners keep concentration away from uninteresting Mathematics problems despite being excited or being too nervous. For example, during Mathematics thinking regulatory strategy addresses a measure of how learners concentrate to pick out only the essentials to focus on. A measure that determines how easy or difficult it is for individual learner to fully concentrate on difficult mathematics problems is known as attentional distractibility. The tendency of learners to use attentional distractibility as strategy to direct concentration contributes to volitional capacity (Molokoli, 2005:125). Thus learners decide to instructively pay attention to that which leads towards accomplishment of Mathematics learning intentions. Moreover Orbell (2003:97) highlights the need for mobilising mechanisms that control attention in order to stay focused on the self-chosen activity and avoid unwanted thoughts or social demands.

According to the PSI theory, activation of the self-system as in self-regulation increases positive mood, which in turn produces increased access to memory and facilitates task performance, particularly where new and creative solutions have to be found (Orbell, 2003:98). In addition, Mathematics learners who operate in the self-regulatory mode when pursuing a challenging goal reasonably use conscious attention control strategies:

“Deliberately paying attention to correct substitution in Mathematics formula as it is important for the problem at hand”

“Learner concentrating only on Mathematics rule that is important at the moment”

“Learner deliberately paying attention to what is important for the Mathematics problem at hand”,

“Keeping learner mind on the main Mathematics topic” and

“Learner starts work on Mathematics assignment with full concentration”.

Orbell (2003:98) asserts that individuals also report the operational availability of implicit attention control in some situations, and during Mathematics learning such actions may include:

“Finding own attention captivated by what one is doing”.

“Learner automatically paying attention only to the correct usage of signs that will bring them closer to their goal”,

“Learner staying focused on the Mathematics homework at hand without any effort”,

“Learner instinctively paying attention to correct application of rule needed for reaching the correct answer”.

In recognition to Winnie’s (2004:1880) thought it is acknowledged that volition is manifested as work habits. For this reason it is assumed that volition strategy of attention control provides is a critical ingredient for effective cognitive tactics and strategies for Mathematics learners to do their work. Hence, as Mathematics learners work on Mathematics problems they exercise control of their cognition by means of attention control. Besides, the two self-regulated learning processes of goal attainment and self-evaluation draw learners’ attention to the steps necessary to perform some Mathematics operation. Pape *et al*. (2003:182) assert that during the volition control phase learners monitor and control their behaviours, cognitions, motivations, and emotions by enlisting strategies such as attention control, encoding control, self-instruction, and attributions. Orbell (2003:97) concurs and highlights that volitional efficiency embraces emotions, attention, arousal and cognitive processes. Thus in keeping with Pape *et al*. (2003:190), it is maintained that the action by Mathematics learners to name and describe their cognitive actions employed to accomplish tasks is critical to attention control. Hence Mathematics attention control also involves focusing learner discussion on the processes they used to accomplish the solution to their Mathematics problem.

Hannula (2006:168) recaps that self-regulation encompasses overall management of one's behaviour through interactive processes between different control systems of attention, meta-cognition, motivation, emotion, action and volition. Even though the modest view by Schoenfeld and Kilpatrick (2008:18) augments ways of seeing and habits of mind to Mathematics content knowledge in powerful learning environments practice disciplines of sense-making, these habits of mind are inclusive of Mathematics learner strategies used to ward off distractions. Hence it is herein upheld, in accord with Taylor (2006:361), that attention is the brain's highest control system that represses distracters. In addition, Diefendorff and Lord (2003:381) even suggest that changes in information processing associated with committing to a specific strategy like increased readiness to engage in action or decreased distractibility enhance Mathematics task achievement.

Along the same line Winne (2005:235) embraces a cognitive model of self-regulation that depicts learners as deciding among volitional learning strategies and who must recognise features of the learning environment that affect odds of success. According to this view, selective attention is intended to encourage attention only to the information-related to goal-oriented actions. Skills for regulating one's volitional processes/activities of meta-volitional skills or volitional self-regulation include keeping up one's attention and motivation to solve a given problem. It is learners' decision to pay attention to that which is important for accomplishing Mathematics goals at hand. However, Taylor (2006:374) stresses that attention is a powerful mechanism, the understanding of which also allows considerable progress to be made in clarifying and explicating certain of the principles of information processing in the brain.

The volitional self-regulatory strategy of attention control informs how Mathematics learners keep concentration in order to stay focused on the Mathematics task and avoid unwanted thoughts or social demands. The next section examines management and effort control volition phase during goal maintenance.

2.7 SELF-REGULATION AND EFFORT CONTROL VOLITIONAL FACTORS (GOAL MAINTENANCE) – ACTION PHASE

2.7.1 Self-control pressure

In order to attain individual goals Mathematics learners and their teachers have set, volition is needed in striving towards these established learning objectives. The individual behavioural reactions and cognitive actions displayed during the process of thinking by Mathematics learners are a matter of their effort input as a result of personal choices they make in response to goal striving. According to PSI theory there are two self-regulatory functions that are distinguishable. One is labelled self-control and it involves the inhibition of impulsive actions in order to maintain a focus on one's goals. In this construct self-control pressure refers to the amount of effort learners deploy through use of volitional strategies towards goal maintenance which is believed to have effect on Mathematics learning. According to Orbell (2003:97), self-control essentially refers to conscious processes like planning, rehearsing one's intentions that inhibit or suppress other cognitive and emotional subsystems and processes in order to protect an on-going intention from competing alternatives.

Most researchers are in agreement on the prime task of volition which is goal-maintenance attained by mechanisms of self-control and self-maintenance, that is achieved by mechanisms of self-regulation. Volitional regulation can be associated with rigid self-control "over control" (Kehr, 2004:486). But according to Kuhl (1981, 1984, 1985, 1992) self-control was originally referred to as "action control" in the theory of action control; it supports the maintenance and enactment of conscious goals and intentions in an explicit memory structure and is facilitated by negative mood. In fact dominant social psychological perspective regarding human volition views the human will as a capacity fuelled by a common limited resource, or willpower. Tasks considered to require willpower include self-control, decision-making, complex problem solving, and conflict resolution (Brass *et al*. 2013:305). Indeed, the persistence to strive towards goals displayed as learners respond during execution of Mathematics tasks, is interpreted as learner diligence. This diligent pursuit and drive towards goals determines Mathematics learner self-control pressure.

It is worthwhile to acknowledge van Oers's (2001:78) suggestion that Mathematics practice comprises different groups of legitimate participants who are willing to deal with numbers, number relations and spatial relations according to accepted values in the community and above all who are willing to pursue the quest for certainty. Along almost similar lines Winne

(2004:1881) posits that learners as agents are purposeful; they look ahead to anticipate the outcomes of engaging in particular tasks using particular tactics and strategies under particular learning environments; they choose to strive for outcomes they value and this sets a course for their engagement, establishing an implementation mind-set. Furthermore, Mathematics learner diligence is a choice determined by individuals in own consideration to put weight behind set learning goals. The importance and pursuit of self-chosen Mathematics learning goals has a bearing on learner self-regulation that brings about self-maintenance.

In the self-evaluation phase of self-regulation Mathematics learners compare own performance against a standard or norm and adjust their learning activities depending on their informed perceptions of the quality of their work. Learning activity adjustments are achieved through self-control means. Wolters and Rosenthal (2000:801) suggest that volitional control strategies in Mathematics classes assist to explain some of the professed self-regulation strategies apart from learner capabilities in Mathematics. Turner and Husman (2008:163) concur and also add that learners' control-related and value-related appraisals are the excellent categories, organising their motivations and emotions. Volitional regulation can be associated with rigid self-control (Kehr, 2004:486). Learners diligently pursue to master Mathematics when it is considered to be of more value or of future interest. Subsequently, self-control pressure directs learner effort and focus towards achievement of learning goals during Mathematics learning. In problem solving some Mathematics learners are able to exert self-control pressure as they willingly explore and try out alternatives without giving up. Exerting self-control pressure is one of distinguishing attribute of high achieving Mathematics learners.

2.7.2 Emotion control

Emotions are considered as embodied states that provide the basis for activity. Drodge and Reid (2000:266) suggest that doing, conjecturing and communicating in a culture of Mathematics is influenced to a far greater degree by the vicissitudes of emotion. Another view on emotions indicate that they can have a crucial role during performance, being able to even stop the execution of the task (Panadero & Alonso-Tapia, 2014:456). The three categories of emotion, based on the time frames during which emotions impact motivation and learning are: (a) process-related emotions that happen during a learning task (e.g., enjoyment, boredom); (b) prospective emotions that are anticipated with respect to future outcomes (e.g., hope, anxiety); and (c) retrospective emotions that happen after task completion (e.g., pride, shame) (Turner & Husman,2008:145). Understanding the role of emotions in the Mathematics classroom implies understanding the nature of these situated processes and the way they relate to learners' problem-solving behaviour (Op 'teynde, De corte & Verschaffel, 2006:193). Furthermore, Op 'teynde *et al*., (2006:194) advance from a socio-constructivist perspective that learnerslearner' emotions and other affective processes are conceived as an integral part of problem solving and learning. On the other hand, high quality Mathematics experiences are connected to emotional states (feeling) and inquiry states (thinking) in which the emotional elements involve a sense of purpose, self-perception of potential for success and willingness and capacity to monitor and control the effects of one's feelings (Malmivuori, 2006:153). In addition some of the dimensions of the emotional state of the problem solver which are of particular importance, are duration of emotional reaction, level of awareness of emotion influencing the solving process and the level of control of the emotional reaction (Gómez-Chacón, 2000:150). So even during learning an emotion is a reflection / refraction in the learner of the current state of the Mathematics activity in relation to the anticipated end and an evaluation of the levels of certainty being able to achieve this end (Roth, 2010:284).

Emotion drives attention, which in turn drives learning, memory and problem solving and almost everything else we do (Sylwester, 1994:62). According to Op't Eynde *et al*., (2006:195) learners' emotional reactions toward Mathematics are the outcome of consciously or subconsciously activated personal evaluative cognitions or appraisals of Mathematics, the self, and Mathematics learning situations. Indeed other researchers hint that powerful emotions are linked to learnerslearner' personal and situation-specific appraisals of the self with respect to their goals and effort in Mathematics classroom interactions (cf., Boekaerts, 1995; Turner *et al.,* 2002, Malmivuori, (2006:151).

Furthermore the significant appeal of emotion during learning is demonstrated by Op 'teynde *et al.* (2006:197) in four different ways. First, emotions are based on learners' cognitive interpretations and appraisals of specific situations. Second, learners construct interpretations and appraisals based on the knowledge they have and the beliefs they hold, and thus they vary by factors such as age, personal history and home culture. Third, emotions are contextualised because individuals create unique appraisals of similar events in different situations. Fourth, emotions are unstable because situations and also the person-in-the-situation continuously develop. When Mathematics learners experience shame, they not only make an attribution of personal causation (e.g., "I caused this"; Weiner, 1985), but they make an attribution of complete failure and low self-worth (e.g. "I am a failure and an awful person"). Hence learners in that state experience low self-esteem with in-the-moment shame because the perceived failure is directly associated with personally valued standards, rules, or goals (Turner & Husman, 2008:141).

Weinstein *et al.* (2000:733) include emotions in defining learning strategies. Learning strategies are considered to include any thought, behaviours, beliefs or emotions that facilitate the acquisition, understanding or later transfer of new knowledge and skills. In this regard Rosetta (2000:143) purports that emotions appear to be strongly connected with selection of learning strategies and self-regulation. Volitional strategies that detect what feelings and moods learners experience while performing difficult Mathematics tasks are of emotion control. Emotion control forms an important aspect of volitional capacity as it describes learners' ability to regulate their emotional experience to ensure that they provide effort and complete academic tasks (Wolters, 2003:190). Emotion control is intended to prevent negative feelings from interfering with goal-oriented actions. Therefore there is need for greater awareness and reaction against emotions as they support a fostering of Mathematics process skill by influencing selection of learning strategies and hence have effect in advancing learner self-regulation.

According to De Corte *et al.* (2000:696), self-regulation of motivational and emotional aspects of the learning and the problem solving processes ask for competence to monitor and control one's volitional processes. When learning situations or tasks are seen as leading to gains in competence at reasonable costs, positive cognitions (e.g. confidence) and emotions (e.g. joy) will be dominant, leading to a willingness to invest effort (learning intention) and to act in the "mastery mode." When learners are not competent or confident in exploring alternative solutions for difficult problems, those with volition seek out help rather than abandoning the learning task (Spector & Kim, 2014:14).

On the other hand, Eccles and Wigfield (2002:126) identify emotion control strategies that involve keeping inhibiting emotional states such as anxiety and depression in check during learning. In this regard learners may find they need to use strategies to quell negative emotions and to boost goal-striving motivation (Turner & Husman, 2008:145). Fredricks, Blumenfeld and Paris (2004:65) highlight that emotional engagement includes interest, values and emotions. Hence learners who value Mathematics independently complete Mathematics homework by practising self-regulatory behaviours such as planning, inhibiting distractions, persisting at difficult assignments, organising the environment, overcoming unwanted emotions, and reflecting on what they have learnt (Ramdass & Zimmerman, 2011:197).

The development of emotional self-regulation competencies through relaxation training, cognitive restructuring or self-instructional training is one way to alter the threat value of anxiety-arousing situations (Cervone *et al.*, 2006:365). Hence, in agreement with Turner and Husman

(2008:166), it is envisaged that using multiple study and volition strategies would facilitate Mathematics learners' self-regulation of stressful emotions.

2.8 POST-ACTION PHASE

2.8.1 Self-reflections

The post-action phase is characterized by self-reflections that contain self-judgment and evaluation procedures, including comparisons of one's behaviour with goals and attributions. The learner evaluates the result of his or her effort and draws conclusions for further learning processes (e.g., how to deal with own mistakes).

2.8.2 Failure control

The extent to which learners indicate how they learn from mistakes and are able to change behaviour when someone points out their mistakes, determine their future achievement in Mathematics. PSI distinguishes between two aspects of self-regulatory ability: failure-related action orientation or the capacity to reduce negative affect and decision-related action orientation or the capacity to generate positive affect when faced with difficulties (Cervone *et al*., 2006:341). Other researchers also provide evidence which suggests that strong negative emotions associated with failure, such as anxiety or fear, and excessive cognitive distraction resulting from failure, are known to impair learning and thus reduce Mathematics achievement (Perry *et al*. 2005:559). In Mathematics class a learner may have an intention to perform some task on board, yet his or her actions may be impeded by uncertainty about peers' reaction or fear of failure. In protecting their ego such learners become passive and experience less cognitive engagement. Even though to some Mathematics learners, failure might be a discouraging factor that diminishes learner interest, to others learner failure forms a basis for increased focus and opportunity on Mathematics learning. Hence in keeping up with Turner and Husman (2008:138) it is also suggested that learners' use of multiple study and volition strategies can facilitate their self-regulation of failure perceptions.

Research has documented the distinct roles of positive (Kuhl & Kazen, 1999) and negative (Baumann & Kuhl, 2002) affect regulation in self-control (Cervone *et al*., 2006:341).

This section highlighted the importance for management and effort control volition phase needed for Mathematics goal intention maintenance. Effort control is achieved through volitional strategies of self-control pressure and emotion control. The post-action phase of self-regulation is mentioned with self-reflections that lead learner to conclusions for further learning process and aspects of failure control are elaborated upon. In the next chapter Mathematics teaching and learning strategies are reviewed, as well as Mathematics achievement and interconnectedness to use of volitional strategies.

CHAPTER 3
THE NEED FOR SELF-REGULATION WITHIN THE EDUCATION SYSTEM MODEL

3.1 INTRODUCTION

The purpose of this chapter is to review some of the identified mathematics teaching and learning strategies and to examine contributory factors that lead to Mathematics achievement. What follows is some discussion on the interconnectedness of learner use of volitional strategies to Mathematics teaching and learning. Emanating research questions and hypotheses which guide the research project are formulated.

3.2 MATHEMATICS TEACHING AND LEARNING STRATEGIES

Mathematics teaching that promotes learner self-regulation is effective, provides learners with sound foundation for successive Mathematics learning and promotes learner confidence. Research shows that productive learning is active/constructive, cumulative, self-regulated, goal-directed, situated, collaborative and an individually different process of meaning construction and knowledge building (; Shuell, 1988; De Corte, 1996; National Research Council, 2000; Mayer, 2001;, De Corte *et al.,,* (2004:369). Hence in this research study Mathematics teaching is characterised by teacher attempts to create an environment conducive learning mathematics. Therefore it is important for teaching to entail encouraging learners to direct and self-regulate their own actions in their quest to acquire Mathematics content knowledge and process skills.

Drawing on ideas of identity and culture, Franke *et al.,* (2007:227) denote that Mathematics teaching entails creating an environment for learning, orchestrating participation so that learners relate to representations of subject matter and to one another in particular ways. Thus it is the upheld view in this research that for effective Mathematics teaching to occur, learning activities are to be structured in ways that allow learners to explore, explain, extend and evaluate their progress. It is detailed by Protheroe (2007:52) that effective Mathematics instruction involves developing learner procedural literacy. Anthony and Walshaw (2009:149) concur and expand that effective Mathematics pedagogy is to be focused on optimising a range of desirable academic outcomes that include conceptual understanding, procedural fluency, strategic competence and adaptive reasoning. Also Shellard and Moyer (2002) highlight that the three critical components of effective Mathematics instruction as teaching for conceptual understanding, developing learner's procedural literacy,and promoting strategic competence through meaningful problem-solving investigations are in agreement. According to the latter view, during concepts-based instruction, teachers are to encourage learners to solve problems in ways that are meaningful to them and to explain how they solved the problem, resulting in an increased awareness that there may be more than one way to solve most problems. Protheroe (2007:53) also asserts that a Mathematics environment that helps learners develop confidence in their own abilities to do Mathematics and gain an even firmer grasp of key concepts and processes is effective. Therefore during Mathematics lessons, promoting situations where learnerlearners are able to freely talk about and write explanations for their mathematical reasoning, increases grasp of learning strategies

On the other hand Weinstein, Acee and Jung (2011:45) maintain that learning strategies involve the use of cognition, metacognition, motivation, affect and behaviour to increase the probability of succeeding in learning, creating meaningful and retrievable memories, and performing higher-order cognitive tasks, such as problem solving. Hence the ability of learners to express their own thought or affective process in emotions is significant during Mathematics learning. Classrooms in which learners are able to express themselves freely without fear of ridicule, using appropriate Mathematics reasoning during problem solving, are gateways to successful and meaningful learning. Effective teachers model the process of explaining and justifying, guiding learners into mathematical conventions (Anthony & Walshaw, 2009:152). Schoenfeld and Kilpatrick (2008:25) also advocate for an inquiry-oriented classroom culture in which the learning community adopts classroom social norms such as the obligation to explain and justify their solutions. Learners are expected to try and understand their peers'learner reasoning, to ask questions where they do not understand and challenge views they doubt. Such a Mathematics teaching approach that encourages learner reasoning is strategic. Camahalan (2006:194) elaborates that when learners are taught to focus on the processes and strategies that help them acquire knowledge and skills, they tend to engage in activities they believe enhance learning, such as to exert effort, persist and use effective strategies. Watson (2002:473) advocates for a proficiency agenda that recognizes and emphasises learner exhibition of the thinking skills neededto learn mathematical concepts. Moreover, cognitive learning strategies are distinguished by including the three characteristics of being goal directed, intentionally invoked and effortful (Weinstein *et al.,* 2000:729). Therefore it is considered that an effective Mathematics teaching approach supports appropriate learner use of learning strategies.

iIn line with Weinstein, *et al.* (2000:741) it is argued that knowledge about strategies and knowledge of the contexts the strategies are used in is not enough during Mathematics instruction. It is asserted that the learner must also want to use the strategy. Hence the learners' will component that is herein conceptualised as volition has a significant role to play on meaningful Mathematics learning. Weinstein *et al*. (2011:47) refer to the motivation and affective components of strategic learning that either contribute to or detract from academic success. Thus Mathematics learners' will is a component corresponding to self-control actions accompanied and directed towards affective arousal. During Mathematics learning the self-controlled actions lead to self-regulated learning. Self-regulation as alluded to in section 2.3 refers to the processes people use to activate and sustain their thoughts, behaviours and emotions to attain learning goals. Self-regulation also includes processes such as setting goals, using strategies to solve problems, self-evaluating one's performance, seeking assistance when needed and satisfaction with one's efforts (Pintrich & De Groot, 1990; Zimmerman, 1994; Ramdass & Zimmerman, 2008:20).

Self-regulatory competencies during Mathematics learning involve executing ways that relate to regulating learners' cognitive processes. The learner regulatory processes are referred to as meta-cognitive or cognitive self-regulation skills. Other regulatory activities involve volitional aspects of planning and monitoring of Mathematics learners' problem-solving processes. De Corte *et al.* (2004:369) in particular refer to skills for regulating one's volitional activities and name them meta-volitional or volitional self-regulation skills. Keeping up one's attention and motivation to solve a given problem are given as examples of volitional skills. In concurrence, Camahalan (2006:202) augments that teaching learnerslearner self-regulated learning strategies is reflective of the life-long goal of education as it entails teaching themlearner the will as well as the skill necessary for learning. Even Pape *et al.* (2003:182) postulate that during forethought phase, self-regulated learners plan their behaviours by analysing tasks and setting goals. Furthermore, Pape *et al.* (2003:182) claim that during the performance or volition control phase, self-regulated learners monitor and control their behaviours, cognitions, motivations and emotions by enlisting strategies such as attention control, encoding control, self-instruction, and attributions.

On the other hand, in Mathematics learning situations some learners may find it difficult to concentrate and learn as they do not make meaning of the subject matter. Above all, some learners may have to confront failure or face competing goals like entertainment. When these goals compete with the learning goals, Mathematics learners experience difficulty of adoption and enactment. It is in this regard that the notion upheld is in agreement with Boekaerts and

Corno (2005:205) and in favour of the application of learned volitional strategies to help protect the intention to learn Mathematics under such conditions of difficulty.

In Mathematics, thinking demands instruction that fosters learner use of self-regulation and learning strategies. According to Watson (2002:473), Mathematics thinking ways include the ability to exemplify, to generalise, to develop and use images, to abstract from experience through reflection on processes, to work with structure, either voluntarily or when helped to do so, to participate in mathematical discussion and to work in complex situations. For these thinking ways to be internalised, frequent practice ought to be learner priority, a process well achieved by self-regulated learners. With regard to instruction, De Corte *et al*. (2000:720) identify three main components of instruction that foster self-regulation. They are realistic and challenging tasks; varieties of teaching methods that include modelling of strategic aspects of problem solving by the teacher; guided practice with coaching and feedback, problem solving in small groups, and whole group instruction; and classroom climates that foster appropriate, positive dispositions toward Mathematics learning. Learner participation in group discussions is enhanced when teachers ensure voluntary learner involvement within atmosphere where learners act freely without fear of shame or ridicule by others. During classroom activities effective teachers are able to facilitate dialogue that is focused towards mathematical argumentation. Persistent learner use of learning strategies impacts on acquisition of Mathematics content knowledge and procedural skills.

This section has highlighted what Mathematics teaching entails. Mathematics teaching involves creating an environment for learning, orchestrating participation so that learners relate to representations of subject matter and to one another in particular ways. In addition teaching helps learners develop confidence in their own abilities to do Mathematics and gain an even firmer grasp of key concepts and processes by making use of learning strategies. These are strategies that facilitate Mathematics understanding, learning, and meaningful encoding. The significant role of the will component to promote self-regulation during Mathematics learning is emphasised. In the next section other factors integrated with Mathematics achievement are examined.

3.3 MATHEMATICS ACHIEVEMENT

Shavelson, McDonnell and Oakes (1987) suggest a model that serves as a guide to explore the causal links for the learners' achievement. The exploration of contextual factors within different levels influencing learners' achievement in Mathematics within the context of South Africa advocates use of such a model. The model presents the education system in terms of inputs (including contexts), processes and outputs. The inputs are the policy-related contexts on a national, provincial and local level from which the intended curriculum (in the meaning of what should be taught in schools and learnt by the learnerslearner is also designed and developed. They also include the antecedents: the economic, physical and human resources supplied to different levels of the system; the characteristics of the teachers, and the background of the learnerslearner. Inputs into the system affect all the processes of education, which may also be seen as the practice in education. Different processes (relating to what is taught and how it is taught) take place within the districts, schools and inside the classrooms in terms of the implemented curriculum (in the meaning of what is actually being taught in the classrooms), teaching (in the meaning of the context and conditions under which teachers work) and instruction. The outputs, also seen as the outcomes, eventuate in terms of the achievement of learners in specific subjects such as Mathematics, participation in class and school activities, and finally learners' attitudes towards subjects and schooling and aspirations for the future (Howie, 2003:4). Indeed, in moving towards school improvement, it was observed by Fullan (2000) that educational reform comes from the mobilisation and coherence of forces both within the school (administrators, teachers, and learners) and outside the school (parents and the community) (Ridlon, 2009:189).

3.3.1 The input as antecedents within education system model.

The focus on learners' characteristics in the development of volition does not preclude study of the influences of teachers, schools, and parents. On the contrary, when viewed from the environmental contextual perspective which drives much of the research on learner development, it necessitates their inclusion. In this regard, the education model as proposed by Howie (2004:153) is suggested. The model enlists inputs that include the antecedents named as the economic, physical and human resources supplied to different levels of the system; the characteristics of the teachers and the background of the learners. It is insinuated that inputs into the system affect the practice of education. For the purpose of this Mathematics research study only teacher characteristics and background of the learners will be considered.

3.3.1.1 The characteristics of the teachers

In Mathematics learning situations teacher characteristics contribute constructively to learners'learner classroom motivational and volitional aspects of learner conduct. For instance Howie (2005:136) asserts that at the classroom level the strength of teachers' attitudes is a predictor of learnerlearners' achievement. Teachers' commitment appears to play a key role in learnerlearners' performance as well. Even the cognitive developmental theory emphasises the role of teachers in developing socio-moral reasoning and behaviour by creating opportunities for their learnerlearners to think cognitively in a more sophisticated, consistent and comprehensive manner. During problem solving, teachers direct treatment of conflict situations into a culture of discussion and role-playing in which there may be an expression of participants' emotions and suggestions for alternative solutions and behavioural choices (Maslovaty, 2000:431).

In the same vein, Levpušcˇek *et al*. (2012:529) provide evidence that teachers' academic support, academic pressure and mastery goal related consistently to how their adolescent learners engaged in academic work, coped with academic difficulty, and their academic achievement. The teacher is responsible for guiding the learners studying as presentedlearner in the Mathematics curriculum. According to Byman and Kansanen (2008:612) the teacher's task in a classroom situation, is to mediate the goals of the curriculum in such a way that the desired learner self-relevance perceptions are developed. The teacher achieves the objective of mediating the goals of the curriculum by being persuasive. Hence, if and when teachers encounter difficulties, they should have some means of persuading the learnerlearners to work (Byman & Kansanen, 2008:612). Brophy (2008:141) views developing an appreciation (of why what is being taught is worth learning) along with knowledge, skills, attitudes and dispositions as intended outcomes of instruction. It is in this regard that knowledge of affective and conative factors (i.e. motivational and volitional aspects of human behaviour) becomes important (Corno, 1993; Corno & Kanfer, 1993; Snow, Corno, & Jackson, 1996). According to Byman and Kansanen (2008: 606) one prerequisite for learners adapting and learning inline with aims and goals of the curriculum is to willingly cooperate and study.

Some researchers advance persuasive debate on teacher characteristics related to teacher pedagogical beliefs about factors impacting on Mathematics learner performance. Howie (2003:13) argues that teachers with strong mathematical pedagogical beliefs and who believe that Mathematics is primarily a formal way of representing the real world; that Mathematics is primarily a practical and structured guide for addressing real situations; who consider an effective approach to be, if learners are having difficulty, give them more practice by themselves during the class; that more than one representation (picture, concrete material, symbol set, etc.) should be used in teaching a Mathematics topic; that Mathematics should be learned as sets of algorithms or rules that cover all possibilities; and that basic computational skills on the part of the teacher are sufficient for teaching secondary school Mathematics, are also those whose learnerlearners are more likely to achieve lower results. Teacher pedagogical knowledge is mentioned together with teacher content and the different school environments among factors that impact differently on learners' achievement (Kanyongo, Schreiber & Brown, 2007:44).

Notably, in Mathematics classes competing goals create a fragmented influence on learner behaviour (see 2.4.3). Learners pursue personal wills, wants and intentions or desires that impact on the optimal motivation to learn. Despite these competing goals, teaching and learning have to continue in ways that meet curriculum objectives. The teacher has to persuade learners to change their behaviour or understanding, judgment or position by appealing to both reason and emotion. As a result of persuasion and elaboration processes, a learner feels the studying activity to be personally important or valuable and participates in it willingly. Stevens *et al*., (2009:904) postulate that self-efficacy forms through four primary sources, mastery, persuasion, vicarious experiences and physiological states and relates to more accurate estimates of one's abilities. Byman and Kansanen (2008: 606) insinuate that in identifying the value of a learning goal, learnerlearners study more volitionally. An example is a learner who willingly does extra homework in Mathematics because such a learner believes it is important for continued success in that subject.

In addition the teacher's task is to mediate the goals of the curriculum in such a way that the desired self-relevance perceptions are developed. From the view of Self-determination Theory of Mmotivation (SDT), people have a natural inclination to engage in activities that are experienced as self-chosen or volitional (Vansteenkiste, Zhou, Lens & Soenens, 2005:468). Teachers can encourage volitional engagement and support learners' autonomy by relying on non-controlling language through flexible messages that are non-evaluative and information rich (Reeve, 2009:169). During Mathematics learning, autonomous actions are those that are regulated and endorsed by the individual learner and are therefore accompanied by a sense of psychological freedom and volition. Vansteenkiste *et al*., (2005:470) contend that autonomy, as defined within SDT, reflects the intrapersonal and phenomenological experience of volition and choice.

Self-determination theory differentiates between autonomously motivated behaviours that are enacted with a sense of volition and psychological freedom and controlled behaviours that are typically executed with a sense of resistance, pressure or obligation (Vansteenkiste *et al.* 2005:469). Teacher autonomy supported climate nurtures critical motivational variables (i.e., self-determined motivation, perceived competence) that predict learnerlearners' intentions to persist in high school (Hardre. & Reeve, 2003:354). Jang, Kim and Reeve, (2012:1177) reiterate that teacher-provided autonomy support is further linked both correlationally and experimentally to a wide range of important educational outcomes, including learnerlearners' classroom engagement, learning (e.g., conceptual understanding), and performance.

Teachers need to provide ongoing "cognitive autonomy support" by, for instance, scaffolding independent and ongoing problem solving, asking learners to evaluate their own work, creating opportunities for learners to ask questions, allowing learners to collaborate and share their expertise, helping learners utilise effective learning strategies to cope with the demands of complex and challenging lessons, and offering opportunities for learners to realign the task to correspond more closely with their personal interests. Thus, inner motivational resources not only energise initial engagement but also sustain its persistence (Reeve, 2009:169).

3.3.1.2 The background of the learners.

Howie (2004:157) indicates that when exploring learners' home background, their personal characteristics, their aptitude and competencies, the following six factors were found to have had a direct effect on South African learners' performance in Mathematics. These are the learners' proficiency in English, their own self-concept in terms of Mathematics, the language learners spoke at home, their socio-economic status at home, whether or not they, their friends and their mothers thought that Mathematics was important, and language of learning and teaching in the classroom.

In this section some contribution of the mentioned factors in relation to volitional aspects and ultimate mathematics achievement are discussed. The socioeconomic status at home comprised parents / guardians of low income and poor educational background that do not provide learners with much needed emotional support. As a result learners are prone to emotional instability. In addition learners grow within the social structure of environment with friends and parents who do not think that Mathematics is important, a factor that affects their emotional well-being and cognitive approach. Howie (2003:13) highlights that the self-concept of the learner (about having difficulty with Mathematics) and the importance of Mathematics according to mother, friends and the learner, are also related to Mathematics achievement. In the research study volitional self-efficacy constitutes Mathematics learner self-concept (see 2.5.1). Some researchers like Maccini, Mulcahy and Wilson (2007:58) show that cognitive, emotional and social factors are found to contribute towards the lack of Mathematics achievement on the part of learners with learning disability.

Learner personal characteristics including aptitude and competencies impact on learner Mathematics learner performance. Indeed some researchers hint that predictors of academic success usually consist of intelligence and non-cognitive measures which include personality traits (Ridgell & Lounsbury, 2004:608; Aremu, Williams & Adesina, 2011:95). Hence the non-cognitive variable of conscientiousness is integrated into this research through its presumed association with intelligence. Conscientiousness is a personality factor related to persistence, discipline, organisation and need for achievement (Moutafi, Furnham & Crump, 2006:33). Conscientiousness is identified as a personality factor that appears to be significantly correlated with intelligence per se. In this regard Moutafi *et al.* (2003:91) explains that less intelligent people cope with their lack of intelligence by becoming more organised, thorough, persistent, and methodical. According to McCrae (2004:472) individuals who score high on this factor have clear goals and the ability to persevere in their efforts to attain them. Hence conscientious-ness is considered a dimension of personality most directly relevant to the accomplishment of Mathematics tasks. This is in view of the fact that the accomplishment of Mathematics learning goals in school often requires persistent and purposive striving attitude. Therefore the influence of persistence in governing attitudinal change can be considered the appropriate medium for Mathematics skill enforcement that in turn should influence achievement. The use of the volition mode of self-regulation control supports learner motivation so that cognitive engagement effects changes in study habits and ultimate achievement in Mathematics (see 2.3).

In addition, (McCrae, 2004:470) some learner have attention deficit/hyperactivity disorder, which is characterised in part by problems with concentration, organisation, and persistence—traits related to conscientiousness. An elaborate record identified six facets of conscientiousness as competence (efficacy), order (planning ahead), dutifulness (following rules), achievement striving (effort), self-discipline, and deliberation. The facets indicate individual differences in persistence, responsibility, and effort, all of which are associated with better academic and occupational performance (Von Stumm, Hell, & Chamorro-Premuzic, 2011:576). Noftle and Robins (2007:126) concur and highlight that the achievement-striving, persevering, and self-controlled aspects of conscientiousness are most important to both high school and college achievement. Conscientious learners may be, relative to their less conscientious peers, more motivated to perform well at academic tasks because of their dutiful nature, effective study habits, confidence in self-perceived academic competence, attentiveness in the classroom and commitment to academic courses, and are more likely to invest effort into learning, to persist and consequently, to succeed academically (Levpušcˇek *et al.,* 2012:527).

Learner interest is included among aptitudes such as prior knowledge, conceptions of learning, learning styles and strategies, motivation and emotions that affect learning (De Corte *et al.* 2004:370). This view, as developed by Skinner, Kindermann and Furrer (2009:495), places interest together with enthusiasm and enjoyment among positive academic emotions that reflect energised emotional states. In support the self-determination theory view is herein advanced with its contention that when learners learn out of personal interest and personal conviction, they are entirely engaged in learning and they will understand better and be more flexible in utilising the newly acquired information (Reeve *et al*. 2004, Vansteenkiste *et al.* 2005:479). Furthermore, Skinner *et al*. (2008:777) insinuate that positive emotions may be one possible driver of learnerlearner's effortful involvement in learning activities. At the same time, emotional disaffection, especially boredom, seems to exert a significant downward pressure on learner's effort and persistence and predicts their withdrawal from academic tasks. This pattern of findings underscores the idea that when learner find learning activities interesting, fun, and enjoyable, they will pay more attention and try harder.

3.3.2 Different processes - inside the classrooms

The teaching style determines learner engagement in class. In the past decade instructional changes have stressed learner engagement through investigations, multiple representations and discussion, primarily through problem-solving activities (Goldsmith & Mark, 1999). The research study by Ridlon (2009:221) shows that learners in the experimental problem-centred learning (PCL) Mathematics group had a significantly higher gain in achievement than did those in the traditional explain-practice group. PCL focuses on actively using the five National Council of Teachers of Mathematics (NCTM) Process Standards of problem solving, reasoning and proof, communication, connections and representations to teach the five content standards and as Ridlon (2009:192) suggests, it becomes difficult to teach content without the benefit of these processes. In addition, during problem solving learners use the executive function of shifting attention, working memory and inhibitory control cognitive processes. Executive function, however, focuses primarily on volitional control of cognitive self-regulatory processes (Blair & Razza, 2007:648). In the Mathematics classroom learners may face the impasse of having to choose between competing goals that draw their attention. A dilemma is taken from spontaneous experiences occurring in daily life which awaken learners' interest and emotional involvement because they are relevant and authentic and relate to real learner behaviour. Therefore, coping with socio-moral dilemmas may contribute effectively to the construction and development of teachers' and learners' metacognitive, decision-making and problem-solving competencies (Maslovaty, 2000:441). Hence the contributive role of volition control is needed to promote problem solving skills.

However, other classroom level factors have been identified as well that affect Mathematics learner performance. According to Howie (2003:10) the factors include teachers' teaching experience, teachers' level of education, time spent on activities, lesson preparation, teaching load, time on task, teachers' attitudes, success attribution, teachers' beliefs, teaching style, resources, limitations and class size. Findings submitted by Howie (2003:10) show that 46% of the variance in the learners' Mathematics scores could be explained by seven factors: the teachers' attitudes, their beliefs about Mathematics, the extent of their teaching and other teaching workload, the size of the class they are teaching, their gender, resources and their dedication towards lesson preparation. Even the dynamic model as used by Creemers and Kyriakides (2010:267) mentions factors at the classroom level related to the key concepts of quality, time on task and opportunity to learn. In addition Schreiber (2002:274) posits the teaching–learning process*,* which includes learner pursuits and teacher activities. The teaching–learning process includes such factors as in-class and out-of-school pursuits or activities (e.g., answering questions in class, working in groups, athletics, employment, or homework). The acknowledgment and refinement of a learner's time is important. Moreover, learners are expected to interact with one another and with their teacher, based on modelling provided by the teacher. On a daily basis, learners are expected to use academic language and discipline-specific thinking as they work together collaboratively (Fisher, Frey & Lapp, 2011:62).

In addition, according to with Skinner *et al.* (2009:498) classroom engagement refers to the extent of learners' active involvement in learning activities. Learner engagement is a multidimensional construct consisting of four relatively equally weighted indicators (behavioural, emotional, cognitive, and voice) whose individual components are all able to explain unique (separate) variances in outcomes such as learner achievement (Reeve, 2009:163). An elaboration on the multidimensional construct nature of engagement is made in that that the four aspects are distinct, yet inter-correlated: (a) on-task attention, effort, and persistence (behavioural engagement; Skinner *et al.,* 2009:495); (b) the presence of task-involving emotions such as interest and the absence of task withdrawing emotions such as distress (emotional engagement; Skinner *et al.* 2009:495); (c) the use of sophisticated and deep, rather than superficial and shallow, learning strategies to create complex knowledge structures (cognitive engagement; Walker, Greene, & Mansell, 2006:5); and (d) the extent to which learners contribute constructively into the flow of the instruction they receive (agentic engagement; Reeve & Tseng, 2011:258, Jang *et al*. 2012:1177). With reference to aspects (c) and (d), meaningful cognitive engagement has been defined as strategy use that combines meaningful processing and self-regulatory strategies such as planning and checking one's work (Walker *et al*. 2006:5), while agentic engagement is defined as learners' constructive contribution into the flow of the instruction they receive (Reeve & Tseng, 2011:258).

In this regard the conceived view is that high-quality learning is the result of behaviours and emotions such as exertion, persistence, interest and enjoyment, which reflect a motivation to master the academic material (Skinner, Furrer, Marchand & Kindermann, 2008:766). Learners will study and learn only if they are motivated to learn (intentional learning), therefore we conceptualise motivation and volition as overlapping and interacting concepts. At this stage reference is made to documented literature by Garcia, Mccann, Turner and Roska (1998 396) who propose that the reasons or incentives for the selection of a particular goal and the resultant intention to pursue such goal, comprise aspects of choice motivation and constitute the pre-decisional phase of the goal-striving process. Furthermore, Garcia *et al*. (1998) expound that executive motivation addresses how intentions are implemented (i.e., what actions will be undertaken and why) and are considered to be issues related to action control, or volition, comprising the post decisional phase of goal-striving. This division of motivation is a central aspect of Kuhl's theory of action control and, indeed, traces back historically to the idea of conation, which encompasses choice as well as volition.

Learners' engagement in a learning activity centres not only around learning that particular lesson, but also around developing the capacity and sense of personal responsibility to generate and regulate autonomous motivation of one's own (Reeve, 2009:168). Perceived autonomy support and classroom engagement both function as antecedents to and consequences of learners' autonomy need satisfaction (Jang *et al*., 2012:1185). Autonomous motivation positively predicts concentration, effective time management and a positive study attitude, whereas it is negatively related to performance anxiety. Conversely, Chinese learners who studied the English course because of external or internal obligations held a more negative attitude, had lower concentration, exhibited more signs of performance anxiety and were less effective in managing their study time (Vansteenkiste *et al*. 2005:474). Furthermore, according to SDT, autonomy is a psychological need and its satisfaction is critical for all individuals' optimal development. Autonomy is not conceptualised as a cognitive preference or an interpersonal value that is more or less emphasised depending on the cultural context, but rather it reflects the self-endorsement of actions on an inner, intra-individual level (Vansteenkiste *et al.*, 2005:479).

When learners manage to concur with or endorse the personal relevance of the behaviour, they are more likely to engage in the activity with a sense of willingness and volition (Vansteenkiste *et al*., 2005:469). This implies that learners can be architects of their own autonomy need satisfaction, at least to the extent that they can be architects of intentional changes in their own course-related behavioural, emotional, cognitive and agentic engagement (Jang *et al*. 2012:1184).

3.3.2.1 Implemented curriculum (relating to what is taught and how it is taught)

The philosophy of the new South African curriculum is learner-centred and problem-based teaching. Outcomes-based education formed the foundation of the curriculum in South Africa from late 90s till 2010. It aimed to enable l learners to achieve to their maximum ability. It did this by setting the outcomes to be achieved at the end of the process. The outcomes encourage a learner-centred and activity-based approach to education. The Revised National Curriculum Statement builds its Learning Outcomes for the General Education and Training Band for Grades R-9 (for schools) on the critical and developmental outcomes that were inspired by the Constitution and developed in a democratic process.

Some of the critical outcomes envisage learners who are able to:

- identify and solve problems and make decisions using critical and creative thinking;
- work effectively with others as members of a team, group, organisation and community;
- organise and manage themselves and their activities responsibly and effectively.

Some of the developmental outcomes envisage learners who are also able to:

- reflect on and explore a variety of strategies to learn more effectively;
- participate as responsible citizens in the life of local, national, and global communities;

The teaching and learning of Mathematics aims to develop the following in the learner:

- a critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations;
- the necessary confidence and competence to deal with any mathematical situation without being hindered by a fear of Mathematics;
- an appreciation for the beauty and elegance of Mathematics;
- a spirit of curiosity; and
- a love for Mathematics.

In addition, the teaching and learning of Mathematics can enable the learner to:

- develop an awareness of the diverse historical, cultural and social practices of Mathematics;
- recognise that Mathematics is a creative part of human activity;
- develop deep conceptual understandings in order to make sense of Mathematics; and
- acquire the specific knowledge and skills necessary for the application of Mathematics to physical, social and mathematical problems.

The Mathematics Learning Area develops:

- *problem solving:* making sense of the problem, analysing and synthesising, and determining and executing solution strategies, as well as validating and interpreting the solutions appropriate to the context.
- *investigating patterns and relationships:* describing, conjecturing, inferring, deducing, reflecting, generalising, predicting, refuting, explaining, specialising, defining, modelling, justifying and representing.

Mathematical knowledge, skills and values will enable the learner to:

- display critical and insightful reasoning and interpretative and communicative skills when dealing with mathematical and contextualised problems (DoE, 2000:4).

A teacher's orientation toward a curriculum influences how learners engage those materials in the classroom as much as the curriculum itself (Ridlon, 2009:191). Teachers are supposed to know the aims and goals of the curriculum and, in addition, the values behind the curriculum. Further, they are expected to accept these values and to internalise the values gradually into their own thinking and activities. That means a personal commitment to thinking and acting according to the purposes stated in the curriculum, which can be described by the term purposiveness (Byman & Kansanen, 2008:604). Purposiveness in the teacher's pedagogical thinking is supposed to indicate how deeply the teacher has become acquainted with the purposes, aims and goals given in the curriculum (Byman & Kansanen, 2008: 617). In the same vein, teachers are to impress upon learners to acquire their own pedagogical thinking. As Byman and Kansanen (2008:617) assert, learners' pedagogical thinking describes the situation in which a learner becomes acquainted with the aims and goals of the curriculum, has accepted them and acts according to them.

3.3.2.2 Teaching (in the meaning of the context)

The teaching and learning is to be embedded in contexts that nurture appropriate values and attitudes. The "context effect" is defined as a notion which implies that conditions such as policies, resources, curricula, goals, values, norms, routines and social relations in the school influence teaching and learning outcomes (Maslovaty, 2000:440). The teaching–learning process includes such factors as in-class and out-of-school pursuits or activities (e.g., answering questions in class, working in groups, athletics, employment, or homework). The acknowledgment and refinement of a learner's time is important (Schreiber, 2002:274).

According to Byman and Kansanen (2008: 605), reaching the learning goals of the curriculum often requires the learners to do a special activity, studying. Studying:

(1) rarely includes direct or frequent intervention by a teacher

(2) is often a solo activity;

(3) often originates with a general goal set by a teacher that the learner subsequently interprets at the studying session's outset and refines in a recursive way as studying unfolds;

(4) quite often involves searching in and synthesising information from multiple sources, such as a textbook, notes taken in a class or borrowed from a friend, a volume of an encyclopedia, video or TV;

(5) quite often occurs in settings where the learner

(6) almost always produces observable traces of cognitive processing in forms such as notes in a notebook or in the margins of a textbook's pages, outlines, summaries, self-generated questions, diagrams, records of attempts to solve problems and, especially, highlighted (or underlined) text.

With regard to the ultimate aim in school being that the learners act pedagogically, the achievement of this goal often needs the teacher to be persuasive (Byman & Kansanen 2008: 605). Hence perceiving teaching as persuasion is one pedagogical approach that may trigger deeper and more enduring transformation in learners' knowledge, interest and beliefs. Persuasion as a model pays homage to learners' existing base of knowledge, interest and beliefs and allows for various perspectives on key concepts and principles. Persuasion also acknowledges that not all constructions or perspectives are equally prized within communities of practice (Alexander *et al*., 2002:811).

Teaching as persuasion is a new metaphor that arises out of the research on persuasion and conceptual change and is focused on changing the conceptual understanding, motivation and beliefs that learners bring to the learning environment. To be persuasive, the teacher must pose stimulating questions, guide learners through open discussion and seek confirming evidence from learners for their ideas (Alexander, 2001:246). As such, this metaphor offers teachers a wealth of possibilities. Also, teaching as persuasion must incorporate some instruction in the processes underlying argumentation or persuasion (Alexander, Fives, Buehl, & Mulhern, 2002:798). However the aim of persuasion is to change learners' behaviours, or their understanding, judgments or position, on a particular topic by appealing both to reason and emotion (Byman & Kansanen 2008: 604). The rich literature on persuasion reminds us that deep and enduring understanding involve emotion and affect, as much as rational or critical thought, an insight Aristotle reached centuries ago (Alexander *et al*. 2002:796).

Some researchers specify that once learners are in school, teachers are to ensure that they engage with the content. This is accomplished when teachers use an intentional instructional framework that provides learners with opportunities to have thinking modelled for them and to engage in productive work with their peers (Fisher *et al*., 2011:57). The upheld view is in line with a teaching style that displays three characteristics which are autonomy supportive: (a) adopting the learners' perspective and frame of reference during instruction; (b) inviting, welcoming, and incorporating learners' thoughts, feelings, and behaviours into the flow of instruction; and (c) supporting learners' capacity for autonomous self-regulation (Jang *et al*. 2012:1177).

3.3.2.3 Instruction

At school instruction is needed that places a high demand on learners' knowledge and application of processes and metacognitive abilities, in order to increase learner problem solving competency. For instance, Cognitive Strategy Instruction (CSI) utilises components of explicit instruction such as modelling, verbal rehearsal and scaffolded instruction to help learners memorise, apply and internalise a cognitive routine to improve performance (Krawec, Huang, Montague, Kressler & Melia de Alba, 2012:81). However cognitive processes are part of metacognitive strategies whereby learners give themselves instructions, ask themselves questions, and evaluate their performance. De Corte *et a*l. (2000:689) contend the need of a mathematical disposition that requires the mastery of knowledge about one's cognitive functioning (meta-cognitive knowledge) on the one hand, and knowledge about one's motivation and emotions that can be used to deliberately improve volitional efficiency (meta-volitional knowledge).

Therefore the research considers meaningful instruction to revolve around first gaining awareness of what motivational and volitional resources learners possess, then finding ways to involve, nurture and develop these inner resources. Undeniably learners have inner motivational resources; for instance learners have psychological needs (autonomy, competence, relatedness), intrinsic motivation, interests, preferences, self-set goals, intrinsic goals, personal strivings, and internalised types of extrinsic motivation such as self-endorsed values (Reeve, 2009:168). Hence teachers can foster volitional functioning by providing learners with the desired amount of choice, by giving a meaningful rationale when choice is constrained, by accepting rather than countering irritation and anger that arises during the learning process, and by using inviting language (e.g. "you can") rather than controlling language (e.g. "you should"). Numerous studies have shown that the benefits of fostering volitional functioning are manifold, including deep-level learning, positive affect, achievement and behavioural persistence (Vansteenkiste *et al*.,, 2012:432). Taking the learners' perspective (i.e. a key element of the promotion of volitional functioning) then allows teachers to provide truly competence-supportive structure, that is, guidance that meets learners' problems and wishes (Vansteenkiste, Sierens, Goossens, Soenens, Dochy, Mouratidis, Aelterman, Haerens & Beyers, 2012:432).

The volition enhancement Mathematics learner programme is envisaged to play some significant role towards improvement of learner achievement.

3.2.3 The outputs as the outcomes –

3.2.3.1 Achievement of learners

Mathematics achievement reflects the extent to which learners attain learning objectives as defined in curricula and the syllabus. In this research study the two indicators of achievement in Mathematics are final grades as assessed by the teacher and learner scores on the circuit examination tests as set by the Department of Education in Moses Kotane Area Project Office in Mathematics.

3.2.3.2 Learners' attitudes towards subjects and schooling

According to the theory of reasoned action, attitudes play a dominant role in translating intentions into action during Mathematics learning. In effective classrooms, teachers project a positive attitude about Mathematics and about their ability to "do" Mathematics. This includes demonstrating enthusiasm for the content as well as a belief that all learners are capable of learning the material, with lessons designed to encourage curiosity, interest, and skill-building (Protherae, 2007:53)

In establishing equitable arrangements, effective teachers pay attention to the different needs that result from different home environments, different languages and different capabilities and perspectives. The positive attitude that develops raises learners' comfort level, enlarges their knowledge base and gives them greater confidence in their capacity to learn and make sense of Mathematics (Anthony & Walshaw, 2009:150).

3.3 INTERCONNECTEDNESS OF PLANNING, ATTENTION CONTROL, SELF-CONTROL PRESSURE, INTENTION MONITORING, SELF EFFICACY, EMOTION AND FAILURE CONTROL, AND MATHEMATICS ACHIEVEMENT

In section 2.4 volitional processes of planning, attention control, self-control pressure, intention monitoring, self-efficacy, emotion and failure control were listed. Earlier research by Corno and Kanfer (1993) emphasised that appropriately applied volitional control helps learners to study by regulating cognitive, motivation and affective processes around challenging goals (Byman & Kansanen 2008: 615). Kuhl (1987) identifies six action control strategies: (1) selective attention intended to encourage attention only to the information related to goal-oriented actions; (2) encoding control intended to facilitate accepting the current task as a requirement to achieve goals; (3) emotion control intended to prevent negative feelings from interfering with goal-oriented actions; (4) motivation control as previously described; (5) environment control intended to minimise distractions by advising learners to let people know their goals and plans; and (6) parsimonious information processing intended to help learners distribute their time and effort effectively and efficiently (Kim & Keller, 2010:411). The research study investigates the contributive role of volitional control processes on cognitive engagement and ultimate effect on Mathematics achievement when teaching fosters learner use of the processes during their learning.

More supportive evidence by Corno (2004) augments that processes of action control or self-regulated activities, such as planning, enable learners to accomplish goals and prioritise and bypass barriers. Hence it is endorsed that volitional processes are needed by Mathematics learners to develop their working styles and work habits. It is alluded that attention shifting, working memory and inhibitory control cognitive processes referred to as executive functions, are utilised in planning, problem solving and goal-directed activity (Miyake, Friedman, Emerson, Witzki & Howerter, 2000:89). Executive function is similar to effortful control in that it refers in part to the ability to inhibit a pre-potent or dominant response in favour of a less salient response. Executive function, nonetheless, focuses primarily on volitional control of cognitive self-regulatory processes, whereas effortful control includes to some extent, although not exclusively by any means, a focus on automatic or non-conscious aspects of emotional reactivity and regulation (Blair & Razza, 2007:648). Indeed, Corno and Randi (1999) affirm that control of cognition is determined by attention control, encoding control and information-processing control. Other researchers like Manning, Glasner and Smith (1996) and Miller (1991) also view regulation of cognition to contain several different subcomponents including planning, selecting, monitoring, evaluating, and debugging as is quoted in (Sperling, Howard, Staley & DuBois, 2004:118).

In addition, when defining volition as transforming desire to action, Keller (2008) highlights the strategies that could help learners take action on their mathematics goals. The part of desire to act explains the need to set a goal, to plan for the goal and to make a commitment to the goal. These components correspond with the sub-concepts of implementation intentions; that is, commitment to goal, formation of intention commitment and intentions for action (Kim & Keller, 2010:410). Goal-striving initiates discrepancy-reduction actions (through proactive implementation intentions) to bring about an outcome that has not yet been realised. Discrepancy reduction acts as a quality-control mechanism for guiding and constraining learner behaviour for the purpose of goal attainment. Therefore, reactive feedback control comes into play in subsequent adjustments of effort to achieve desired outcomes (Turner & Husman, 2008:143).

Mathematics learners in the process goal condition report a higher degree of self-efficacy, more satisfaction with their performance and more strategic attributions than learners in the outcome goal condition. Moreover, perception of higher self-efficacy leads to setting higher goals; the individual is less afraid of failure and is willing to explore new approaches to solve the problem when previous ones prove to be unsuccessful (Woolfolk, 2001; Levpušcˇek *et al.* 2012:530). Above all, self-confidence expressed in self-efficacy in Mathematics plays a significant role in learners' Mathematics self-system structures, including their powerful self-emotions as well as their important self-regulatory behavioural patterns and Mathematics performance (Malmivuori, 2006:158). Learners who self-regulate their learning are engaged actively and constructively in a process of meaning generation and adapt their thoughts, feelings and actions as needed to affect their learning and motivation (Boekaerts & Corno, 2005:201). Hence it is also conceived that Mathematics learners' practice of volitional mode of self-regulation should positively impact on Mathematics achievement.

3.4 PRACTICAL CONSIDERATION FOR VOLITIONAL ENHANCEMENT TRATEGY SELF-REGULATION AND IMPLEMENTATION PROGRAMME

During Mathematics learning practice learners may not easily find meaning in the Mathematics matter at hand. In some instances learners may have to confront failure, coercion or deal with competing goals like entertainment, belonging, safety and social support goals. It is under such circumstances when the importance of learner use of volitional strategies is emphasised to them so that they do not give up. Subsequently there is a need to make learners aware of the knowledge of what, how, why and when to use the following strategies:in particular, strategies of planning and initiating, self-control pressure, intention monitoring and attention control are needed for learner goal-maintenance (self-control). Strategies of increased awareness of volitional self-efficacy, emotional control and failure control are needed for learner self-maintenance (self-regulated).

In this regard, a volitional enhancement self-regulation strategy and implementation programme is introduced. The intervention programme entails firstly introducing volitional strategies through explicit instruction. Each strategy category is written, learners are assisted to state, describe and classify several strategies they use in order to raise awareness of both self-maintenance and goal maintenance. The purpose of each strategy is to improve learners' self-regulation of their a) personal functioning, b) Mathematics behavioural performance, and c) learning environment

The purpose of the self-regulation forms is to help learners develop better study habits for Mathematics classes. Thus learners are helped to track their performance trend in grades and study habits. What then follows is the use of volitional strategies together with learners' performance outcomes being consistently monitored. Monitoring generates feedback that provides information for confirming or re-examining and modifying strategies in order to select and use more productive procedures. In the process learners are asked to identify categories of instructional behaviours that enable or impede progress toward attaining the instructional goals. And lastly, learners similarly identify categories of their behaviours that have enabled or impeded progress toward attaining learning goals.

The used strategy categories, including self-evaluating; organising and transforming; goal setting and planning; seeking information; keeping records and monitoring; environmental structuring; self-consequences; rehearsing and memorising; seeking social assistance; and reviewing records (Zimmerman and Martinez-Pons, 1986), are to help learners think about and articulate their strategies.

A recording sheet equivalent to a learner diary is introduced and issued to learners to keep record of their cognitive behavioural practices.

3.5 RESEARCH QUESTIONS

Mathematics learners’ goal maintenance and self-maintenance coined as effective coping and self-management can be brought about through sound intervention focused on volitional strategy used by learners who need help and this can make an important difference in their struggle to adjust to school work (Boekaerts & Corno, 2005:223). Consequently the intervention is implemented in the real and complex context of the classroom and is primarily focused on the development of volition by changing the traditional learner view on self-management.

The two main research questions are then asked: Can learners’ Mathematics- related volitional use be enhanced through an educational intervention in an innovative learner view on self-management? In other words, can learner volition use be refined?

The second purpose of the study is to see whether the innovative learner self-regulation view would also affect learners’ perceptions of their own effort and understanding in Mathematics.

Thus, the second research question is: Can learners' self-evaluation of their own effort and understanding in Mathematics also be improved through the educational intervention?

Third purpose of the study was to examine if, and to what extent, learner volition contributed to their achievement in the domain. Thus, the third research question is: Does learners' use of volition predict their achievement in Mathematics?

Therefore the main research question was poised was do Mathematics learners who make use of volitional strategies achieve at a higher level than learners who do not make use of their strategies in grade 9? The question was further broken up into specific questions that in grade 9:

- How do Mathematics learners with more sense of planning and initiating achieve in comparison to learners with less sense of ability to plan and initiate activities?
- How do Mathematics learners who often monitor their intentions perform in comparison to learners who seldom monitor their intentions?
- How do Mathematics learners who are less distracted in attention perform higher when compared to learners who are easily distracted?
- How do Mathematics learners who exert more self-control pressure achieve when compared to learners with less self-control?
- How do Mathematics learners with more tendencies to control failure and emotions achieve when compared to learners with less tendency to control failure and own emotions?
- How do Mathematics learners with high volitional self-efficacy achieve in comparison to learners with low volitional self-efficacy?

In conclusion this chapter highlighted some Mathematics teaching and learning strategies together with factors believed to be of contributory significance towards Mathematics achievement. A discussion on the interconnectedness of learner uses of volitional strategies to Mathematics teaching and learning was presented. The emanating research questions were formulated, which guide the research project. The next chapter deals with the research design and methodology.

CHAPTER 4
RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

In Chapters 2 and 3, the literature review provided a theoretical perspective regarding the key research questions on developing a volitional enhancement model to improve Mathematics performance of learners in grade 9. These previous chapters formed the contextual and theoretical framework for the research report.

The questions of what to investigate and how to do the investigation are addressed in the descriptive detail of the research design (Van Vuuren, 2008: 179). This chapter describes the systematic and focused investigation approach according to the following topics: purpose of empirical section, mixed method research approach, quantitative research and qualitative research, ethical aspects and administrative procedures.

4.2 PURPOSE OF THE INVESTIGATION

The investigation section of this research report intends to describe a scientific process of applicable research design that will lead to valid and reliable quantitative and qualitative data concerning the research problem and accompanying research questions guiding this study. The research problem involves dealing with some identified contextual factors which affect learner engagement patterns. These contextual factors that impact on both Mathematics thinking and ultimate learner achievement include lack of enthusiastic volitional use in some selected grade 9 classes situated in a rural area.

Hence the purpose of this research in broad is to develop, implement and evaluate a model to enhance learners' use of volitional strategies so as to augment Mathematics teaching and learner achievement in grade 9, particularly in a rural community school.

The research aim includes:

a) Developing a Mathematics teaching and learning model that will support learner use of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy.

b) Identifying Mathematics strengths and weaknesses learners develop when their sense of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy use is increased.

c) Examining the effects of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy on grade 9 Mathematical learner achievement and

d) Determining how application of the developed model influences teaching and learner achievement in grade 9 Mathematics classrooms (see section 1. 2).

4.3 RESEARCH QUESTIONS

With regard to the above aims the four main research questions were asked

Research question 1

Can learner' Mathematics-related volitional use be enhanced through an educational intervention in an innovative learner view on self-regulation?

Research question 2

Can learners' self-evaluation of their own effort and understanding in Mathematics also be improved through such educational intervention?

Research question 3

Can learners' self-evaluation of their own volition control and self-regulation in Mathematics be improved through the educational intervention?

Research question 4

Do learners' volition uses predict their achievement in Mathematics?

The fourth question was further broken up into specific questions:

- How do Mathematics learners with more sense of planning and initiating achieve in comparison to learners with less sense of planning and initiating?
- How do Mathematics learners who often monitor their intentions perform in comparison to learners who seldom monitor their intentions?
- How do Mathematics learners whose attention is less easily distracted perform in comparison to learners who are easily distracted?
- How do Mathematics learners who exert more self-control pressure achieve in comparison to learners with less self-control?
- How do Mathematics learners with more tendencies to control failure and emotions achieve in comparison to learners with no tendency to control failure and emotions?
- How do Mathematics learners with high volitional self-efficacy perform in comparison to learners with low volitional self-efficacy?

4.4 RESEARCH DESIGN

4.4.1 Mixed method research

The positivist researchers believe that knowledge is objective and does not depend on the perception of any one individual. Thus, knowledge is located outside any single individual and is something apart from them (Creswell & Miller, 1997:37). In line with the philosophical view, positivism suggests that there is a set of true concepts and causal relationships that exist in the world, which can be measured and analysed quantitatively (Barnes, 2012:465). But, other researchers as purists restrict themselves exclusively either to quantitative or to qualitative research methods. The quantitative purists maintain that social science inquiry should be objective. That is, time- and context-free generalizations are desirable and possible, and real causes of social scientific outcomes can be determined reliably and validly (Johnson & Onwuegbuzie, 2004:14). Hence the major characteristics of traditional quantitative research are a focus on deduction, confirmation, theory/hypothesis testing, explanation, prediction, standardized data collection and statistical analysis (Johnson & Onwuegbuzie, 2004:18)

On the other hand, one paradigm conceives knowledge to reside “inside” the individual as opposed to “out there” beyond the individual. People attain this knowledge by sensing their world and giving meaning to these senses through socially constructed interactions and discussions (Creswell & Miller, 1997:37). This qualitative view suggests that it is the human subjective perceptions and experiences of the social world that matter, and that multiple versions of reality may exist (Barnes, 2012:465). In addition qualitative purists contend that multiple-constructed realities abound, that time- and context-free generalizations are neither desirable nor possible, that research is value-bound, that it is impossible to fully differentiate causes and effects, that logic flows from specific to general (e.g., explanations are generated inductively from the data) and that knower and known cannot be separated because the subjective knower is the only source of reality (Johnson & Onwuegbuzie, 2004:14). Therefore the major characteristics of traditional qualitative research are induction, discovery, exploration, theory/ hypothesis generation, the researcher as the primary "instrument" of data collection, and qualitative analysis (Johnson & Onwuegbuzie, 2004:18).

The mixed methods approach is philosophically the "third wave" or third research movement, a movement that moves past the paradigm wars by offering a logical and practical alternative (Johnson & Onwuegbuzie, 2004:17). Mixed methods research is defined here as the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study. Leech and Onwuegbuzie (2009:268) elaborate that mixed methods research represents research that involves collecting, analysing and interpreting quantitative and qualitative data in a single study or in a series of studies that investigate the same underlying phenomenon. Creswell and Garrett (2008:322) concur that mixed methods is an approach to inquiry in which the researcher links, in some way (e.g. merges, integrates, connects), both quantitative and qualitative data to provide a unified understanding of a research problem.

Hanson,Creswell, Clark, Petska and Creswell (2005:224) highlight that mixed methods research is defined as “the collection or analysis of both quantitative and qualitative data in a single study in which the data are collected concurrently or sequentially, are given a priority, and involve the integration of the data at one or more stages in the process of research”. Leech and Onwuegbuzie (2009:273) add that mixed methods is multi-phased study, comprising the following five specific designs: sequential studies, parallel/simultaneous studies, equivalent status designs, dominant-less dominant designs, and designs with multilevel use of approaches wherein researchers utilize different techniques at different levels of data aggregation.

In order to realize the purpose of the current study a sequential mixed methods design is used. This is a sequential explanatory design that requires two phases of data collection, quantitative data collection followed sequentially by qualitative data collection (Creswell, 2009:103). In this case quantitative data are collected from grade 9 Mathematics learners and statistically analysed to obtain results. These are then followed up by qualitative data obtained from a few individuals to probe or explore those results in more depth.

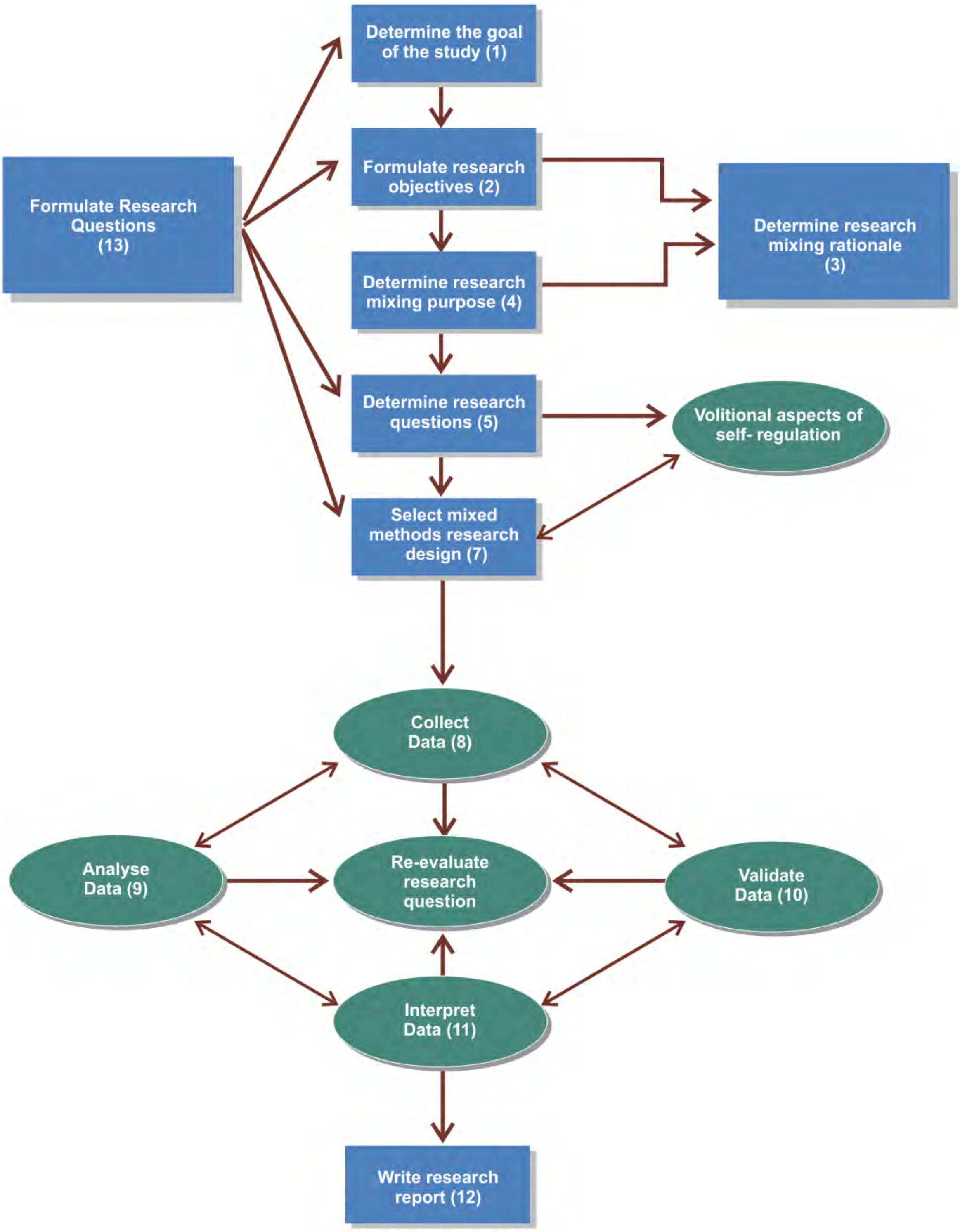


Figure 4.1 Steps in mixed methods research process

4.4.2 The purpose for conducting mixed method research

In this research project the intention is to use both quantitative and qualitative methods to explore and report on descriptive data. Onwuegbuzie and Leech (2005:384) assert that the pragmatic approach attempts to develop knowledge through workable and testable ideas. Furthermore, pragmatic researchers utilise mixed method research approach within the same inquiry; they are able to delve further into a dataset to understand its meaning and to use one method to verify findings from the other method. By using a variety of research methods the researcher views knowledge pragmatically as based on studying "problems" or "issues", Creswell and Miller (1997:39) contend. The researcher starts with a problem that needs to be solved and uses the tools available to collect data and then analyse data. Therefore *pragmatic* is a term implying that the problem is central to the research methodology, and that researchers combine qualitative and quantitative methods to address specific problems.

In the field of mixed methods approach a number of scholars embrace pragmatism as the philosophical underpinning for conducting mixed methods research (Creswell, & Garrett, 2008:327). No wonder, as consideration of pragmatism offers an immediate and useful middle position philosophically and methodologically; it offers a practical and outcome-oriented method of inquiry that is based on action and leads, iteratively, to further action and the elimination of doubt; and it offers a method for selecting methodological mixes that can help researchers better answer many of their research questions (Johnson & Onwuegbuzie, 2004:17).

In addition Leech and Onwuegbuzie (2010:63) mention the four major rationales for mixing both quantitative and qualitative approaches. These rationales are namely participant enrichment, instrument fidelity, treatment integrity, and significance enhancement. Even though the researcher's rationale for using mixed methods approach was mostly influenced by need for treatment integrity and significance enhancement some elaboration on other rationale is put forth.

- Participant enrichment

  Participant enrichment refers to the mixing of qualitative and quantitative techniques for the rationale of optimising the sample. The purpose here is to determine whether participants are comparable across intervention conditions.

- Instrument fidelity

  Instrument fidelity involves procedures used by the researcher to maximize appropriateness and/or utility of the quantitative and/or qualitative instruments used in the study. In mind is a twofold purpose to validate individual scores on outcomes measures and explain within- and between-participant variations in outcomes on instruments.

- Treatment integrity

  Treatment integrity involves the mixing of quantitative and qualitative techniques for the rationale of assessing the fidelity of interventions, programmes, or treatments. According to Leech and Onwuegbuzie (2010:63) this rationale is particularly pertinent for counselling research in which a treatment (e.g., cognitive behaviour intervention) is administered to participants either randomly (i.e., experiment) or non-randomly (i.e., quasi-experiment). For an intervention to possess integrity, it should be implemented exactly as intended. Hence the purpose is to evaluate the fidelity of implementing the intervention and how it has worked.

- Significance enhancement

  Significance enhancement represents mixing qualitative and quantitative approaches for the rationale of maximizing interpretation of the findings. A researcher can use quantitative data to augment qualitative analyses, qualitative data to enhance statistical analyses, or both. Moreover, using quantitative and qualitative data analysis techniques within the same research often enhances the interpretation of significant findings (Onwuegbuzie & Leech, 2004:770; Leech & Onwuegbuzie, 2010:63).

4.4.3 The mixed-methods sequential explanatory design

There are three identified sequential designs within the six primary types of mixed method research designs named explanatory, exploratory and transformative while three other concurrent designs are known as triangulation, nested, and transformative (Hanson et al. 2005:228). One of these designs, the mixed-methods sequential explanatory design, implies collecting and analysing first quantitative and then qualitative data in two consecutive phases within one study. In order to realize the purpose of the present study a sequential explanatory design was used.

The mixed-methods sequential explanatory design consisted of two distinct phases: quantitative followed by qualitative. In addition, in the mixed-methods sequential design, the quantitative and qualitative phases were connected in the intermediate stage when the results of the data analysis in the first phase of the study informed the data collection in the second phase. The two phases of the sequential explanatory design were also connected while selecting the participants for the qualitative follow-up analysis based on the quantitative results from the first phase. In this sequential design, the researcher first collected and analysed the quantitative (numeric) data. Another connecting point was the development of the qualitative data collection protocols, grounded in the results from the first, quantitative, phase, to investigate those results in more depth through collecting and analysing the qualitative data in the second phase of the study.

The quantitative and qualitative phases were connected during the intermediate stage in the research process by selecting the participants for the qualitative interviews from those who responded to the survey in the first, quantitative, phase based on their Mathematics achievement. The second connecting point included developing the interview questions for the qualitative data collection based on the results to determine which continuous variables discriminate between low and high achieving groups in the first, quantitative, phase. The quantitative and qualitative approaches were mixed at the sequential design stage by introducing both quantitative and qualitative research questions. The integrated results from the quantitative and qualitative phases were used in the interpretation of the outcomes of the entire study.

The interview protocol was developed, the content of which was grounded in the quantitative results from the first phase. In addition the goal of the second, qualitative, phase was to explore and elaborate on the results from the first, quantitative, phase of the study. Hence researcher wanted to understand why certain predictor variables contributed differently to the function discriminating low and high achieving groups as related to their effort sustenance in the volition intervention model. Thus, three open-ended questions in the interview protocol explored the role of goal pursuit, planning and initiating. Seven other open-ended questions explored the role of self-control pressure, emotion control and attention control as related to learners' effort sustenance. The other five open-ended questions in the interview protocol explored important role of intention monitoring and failure control during volition mode of self-regulation. The interview questions were pilot tested on one participant, purposefully selected from those who had completed survey in the first quantitative phase. The order of the protocol questions was revised and additional probing questions developed based on this pilot interview analysis.

The qualitative (text) data were collected and analysed second in the sequence. The qualitative data helped to explain, or elaborate on, the quantitative results obtained in the first phase. The second, qualitative, phase built on the first, quantitative, phase, and the two phases were connected in the intermediate stage in the study. The rationale for this approach was that the quantitative data and their subsequent analysis provided a general understanding of the research problem. The qualitative data and their analysis helped refine and explain those statistical results by exploring participants' views in more depth (Barnes,2012:470). Hence the advantages of sequential explanatory design include straightforwardness and opportunities for the exploration of the quantitative results in more detail.

The results of the quantitative and qualitative phases were integrated during the discussion of the outcomes of the entire study. Some research questions were asked to better understand reasons behind learners' effort sustenance in the volition intervention model. In the discussion section, the results were combined from both phases of the study to more fully answer those questions and a more robust and meaningful picture of the research problem was developed.

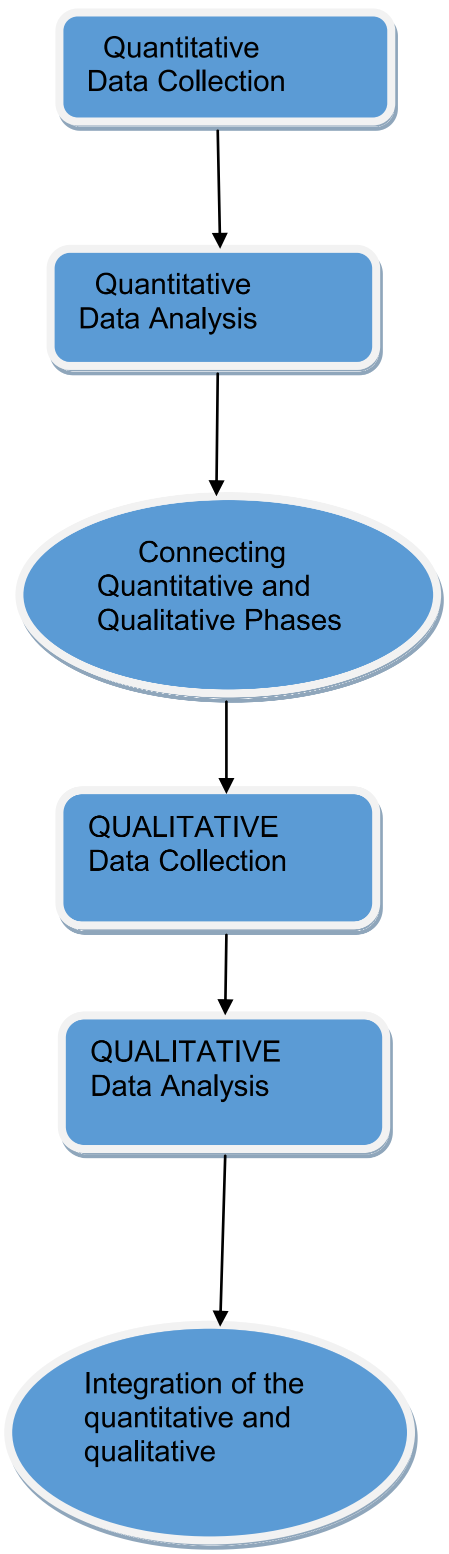
The purpose of this mixed-methods sequential explanatory study was to identify factors contributing to learners' effort sustenance in the Mathematics intervention model by obtaining quantitative results from a survey of 154 of experiment and control learners and then following up with twelve purposefully selected individuals to explore those results in more depth through a qualitative analysis. The qualitative analysis involved research techniques that include interviews, participant observations, and document analysis. The research process involved Grade 9 learners at community schools (A and B) in rural area. In the first, quantitative, phase of the study, the quantitative research questions focused on how selected internal variables in the volition intervention model (such as volition aspects of self-regulation, volition control and self-reflections) served as predictors to learners' volition enhancement during mathematics learning.

In the second, qualitative, phase, twelve learners from two distinct participant groups of low and high achieving learners in Mathematics, explored in depth the results from the statistical tests. Qualitative interviews and observations were used to probe significant enhancement by exploring aspects of the volition strategy use. In this phase, the research questions addressed the seven internal factors found to be differently contributing to Mathematics achievement discriminating the two groups: lack of energy, planning and initiating, volitional self-efficacy, intention monitoring, attention control, self-control pressure, emotion control and failure control.

The first interpretation of the results helped answer the study's major quantitative research question: "Can learners' Mathematics- related volitional use be enhanced through an educational intervention in an innovative learner view on self-regulation?" Then some discussion on the interview and observations findings that were aimed at answering the guiding research questions in the qualitative phase of the study: "Can learners' self-evaluation of their own effort and understanding in Mathematics also be improved through the educational intervention? Can learners' self-evaluation of their own volition control and self-regulation in Mathematics be improved through the educational intervention? And do learners' volition uses predict their achievement in Mathematics?" This process allowed for the findings from the second, qualitative, phase to further clarify and explain the statistical results from the first, quantitative, phase.

The research study results were discussed in detail by grouping the findings to the corresponding quantitative and qualitative research sub-questions related to each of the explored factors affecting enhanced volitional strategies' use and Mathematics learners' achievement. The discussion was augmented by citing related literature, reflecting both quantitative and qualitative published studies on volition control. Thus, combining the quantitative and qualitative findings helped explain the results of the statistical tests by probing further into a dataset to understand its meaning and to use one method to verify findings stemming from the other method (Onwuegbuzie & Leech, 2004:771). This is the elaborating purpose for a mixed-methods sequential explanatory design. Figure 4.2 illustrates the adapted graphical representation of the mixed-methods sequential explanatory design procedures used (Ivankova, Creswell & Stick, 2006:16).

Phase



Procedure

- Cross sectional VCI survey (n = 154)
- Data screening (Analysis of Variance)
- Factor analysis
- Frequencies
- ANOVA
- SPSS quan. Software
- Purposefully selecting 6 participants from each group based on mathematics achievement
- Developing interview questions
- Individual interviews
- Volition observation tool
- Researcher notes
- Coding and thematic analysis
- Interpretation and explanation of quantitative and qualitative results

Product

- Numeric data
- Descriptive statistics, linearity, normality, variance outliers
- Factor loading
- Descriptive statistics
- Discriminant funtions
- Sample (n = 6)
- Interview protocol
- Interview transcripts
- Learner volition profile
- Notes
- Similar and different themes and categories
- Discussion
- Implications
- Future research

Figure 4.2 Mixed-methods sequential explanatory design procedures

4.4.4 Strength of the pragmatic approach

Paradigms are shared belief systems that influence the kinds of knowledge researchers seek and how they interpret the evidence they collect (Morgan, 2007:50). But with regard to combining qualitative and quantitative methods, paradigms as epistemological stances have had a major influence on discussions about whether this merger is possible, let alone desirable. According to Hanson (2005:225) and colleagues, mixed methods research approach was viewed as untenable (i.e., incommensurable or incompatible) because certain paradigms and methods could not “fit” together legitimately. Even the incompatibility thesis (Howe, 1988), posits that qualitative and quantitative research paradigms, including their associated methods, cannot and should not be mixed (Johnson & Onwuegbuzie, 2004:14). Barnes (2012:463) concurs and highlights that the incompatibility thesis suggests that the two methods differ fundamentally in their understandings of the social world and therefore cannot be mixed.

On the other hand pragmatism is best placed to offer the mixed methods movement a set of philosophical tools that are particularly useful to deconstruct the supposed incompatibility of quantitative and qualitative methods. While acknowledging differences between quantitative and qualitative methods Johnson and Onwuegbuzie, (2004:18) argue that there were also areas of overlap and, importantly, that the strengths of each method could add value to any given research study beyond what each of them could contribute alone. Creswell and Garrett (2008:322) as well, are of the opinion that when researchers bring together both quantitative and qualitative research, the strengths of both approaches are combined, leading to what can be assumed to be a better understanding of research problems than either approach alone. And a researcher can use the strengths of an additional method to overcome the weaknesses in another method by using both in a research study.

Quantitative research methods lead to knowledge attainment by deductive means whilst qualitative research methods employ inductive means to obtain information. In terms of the use of theory, pragmatism suggests that social researchers often work between deduction and induction through what is commonly called abduction (Barnes 2012:466). Morgan (2007:71) reiterates that the pragmatic approach relies on a version of abductive reasoning that moves back and forth between induction and deduction—first converting observations into theories and then assessing those theories through action. Subsequently the inductive results from a qualitative approach serve as inputs to the deductive goals of a quantitative approach and vice versa. Hence a pragmatic approach can provide stronger evidence for a conclusion through convergence and corroboration of findings. It is in this regard that the researcher upholds a pragmatic approach to research.

Besides, Johnson and Onwuegbuzie (2004:17) suggest that pragmatism offers an immediate and useful middle position philosophically and methodologically; it offers a practical and outcome-oriented method of inquiry that is based on action and leads, iteratively, to further action and the elimination of doubt; and it offers a method for selecting methodological mixes that can help researchers better answer many of their research questions. In addition, it is considered in agreement with Morgan (2007:73) that emphasis on the connection between epistemological concerns about the nature of the knowledge produced and technical concerns about the methods used to generate that knowledge is the great strength of the pragmatic approach to social science research methodology.

4.5 DATA COLLECTION PROCEDURE

The method employed entails first conducting some literature review that was followed by the planning meetings with all relevant stakeholders in the research project and implementation of the phase model. Research followed a mixed method approach that used a variety of evaluation techniques which included pre-/post-/retention tests, pre-/post-/retention using VCI instruments. The administration of pre-/post-/retention using VCI instruments was made on the same dates to avoid contamination. A developed volition management programme was implemented and learners were encouraged to use volition observation tools. Both qualitative and quantitative evaluations were implemented in the research design.

The sequential explanatory design was used to collect data over the period of time in two consecutive phases. Thus, the researcher first collected and analysed the quantitative data. Qualitative data were collected in the second phase of the study and were related to the outcomes from the first, quantitative, phase. The decision to follow the quantitative-qualitative data collection and analysis sequence in this design depended on the fact that study purpose was to develop, implement and evaluate a model to enhance volition strategies use. In order to respond to the research questions (par. 1.3.1) the contextual field-based explanation of the statistical results was needed.

In specific terms to realize the mentioned purpose of the research, a two-way randomized, crossover over research design was used to examine the intense effect of volition enhancement training on Mathematics performance measurement of grade 9 learners. According to Bose (2002:185), cross-over designs are used for experiments in which each of the experimental subjects or units receive different treatments successively over a number of time periods. Bose (2002:185) further enlightens that an observation is affected not only by the direct effect of a treatment in the period in which it is applied, but also by the effect of a treatment applied in an earlier period. Therefore the presence of 'carryover' effects complicates the analysis of data.

In this investigation the subjects consisted of two groups of grade 9 Mathematics learners from schools 1 and 2 respectively. One group (n=88) formed the experimental group and the other, the control group (n=66). After conducting the pre-tests, the crossover design was implemented by subjecting the experimental group to the treatment of implementing volition management programme while normal teaching was continued with the control group.

The Post-test was conducted eight weeks later to eliminate any cross-over effect from the first to the second testing opportunity. The control group was, however, now subjected to the same conditions as experimental group, while the experimental group was taught by the subject teacher. The overview of the crossover design model is given in table 4.3 below where the volition intervention was first introduced to the experimental group and at later stage to the control group.

Table 4.1: Phases of cross-over design research model to be implemented

Phases	Activity	Experimental Group School 1	Control Group School 2
Phase 1- Introductory	1) Pre-Test Administer survey questionnaire on VCI	Learners complete VCI questionnaire	Learners complete VCI questionnaire
	2) Writing of pre-tests	Learners take standard maths achievement pre-test prepared by APO (Moses Kotane East)	Learners take same maths achievement pre-test
Phase 2- Interim Intervention	Interim Intervention with experimental group	Learners were treated with a teaching and learning model aimed at intensifying learner usage of identified volitional strategies for period of 28 lessons. For evaluation purposes field notes were taken during teaching.	Learners undergo their normal regular Mathematics teaching programme.
Phase 3 - Experimental closure	1) Administer questionnaire on VCI	Learners complete a VCI questionnaire	Learners complete a VCI questionnaire
	2) Post-test	Learners write standard achievement test	Learners write standard achievement test
Phase 4- Final Intervention	Final Intervention with control group	Teachers continue treatment utilising newly acquired modelling learning environment without help of researcher	Learners are treated with a teaching and learning model aimed at intensifying learner usage of identified volitional strategies for period of 28 lessons. For evaluation purposes field notes are taken during teaching.
Phase 5 - Control Closure	1) Retention Test	Learners write a standard maths achievement test	Learners write a standard maths achievement test
	2) Survey questionnaire on VCI.	Learners complete VCI questionnaire	Learners complete VCI questionnaire

Phase 1:

The pre-phase involved administering to both the experimental and control groups a survey VCI questionnaire that comprised 68 items on learner volition strategy use. Learners in both the experimental and control groups took Mathematics pre-test (T1) provided by the Moses Kotane APO (NWED) in order to determine initial achievement standard level. The pre-phase also involved designing of a teaching and learning model aimed at intensifying learner usage of identified volitional strategies.

Phase 2:

The second phase involved implementation of the intervention programme to learners in the experimental group for 40 lessons. In this phase activities were suggested that supported learner use of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional efficacy. This phase of an experimental intervention required use of strategic acts of volition applied and reinforcement thereof while learners were executing series of Mathematics activities on which they seemed weak. This was followed by both groups writing the relevant standard Mathematics test (T2) provided by the Moses Kotane APO (NWED), and responding to VCI survey (68 items). The tests were also written on fixed dates and times at the different schools.

The volition self-management learner program outline

The volitional strategy use and intervention in Mathematics programme designed and facilitated by the researcher was done within eight weeks, for a total of 40 sessions. Detailed lesson plans for 40 sessions were written to ensure effective implementation of the program. Volitional strategy use and intervention instruction started with the development of the learners' self-regulation belief system. The researcher as facilitator guided learners on how to develop the important belief orientation to understand, acquire and execute target volitional strategies. The main purpose of volitional strategy use, and when and how to use the strategies, were discussed and explained by the researcher.

The researcher herein refered to as facilitator then explicitly taught and demonstrated how the strategies were used with the aid of the appropriate self-instructions techniques. The self-instructions included the combination of problem definition, planning, strategy use, self-evaluation, coping and error correction, and self-talk prompts. Collaborative and independent practices of the learners were used to monitor the efficient use of the volitional strategies. The first seven sessions oriented learners to the value of personal responsibility, self-efficacy, learning goals and attribution to effort. The facilitator delivered lectures with the aid of storytelling and group sharing of ideas. Participants were asked to share their goals and ambitions in life through the lessons discussed.

Sessions eight to fourteen were conducted to formally introduce Julius Kuhl and Arno Fuhrmann (1998) self-control learning strategies. Each strategy was explained emphasising its use and importance to learning. Participants were given opportunities to practise each strategy on their own. They were explicitly taught how to write learning goals as well as how to properly pace, sequence and plan activities. The researcher as facilitator demonstrated the self-talk strategy for recommitment, and then asked volunteers to do the same. The learners together produced records of tests, class works and assignments to monitor their own performance and progress in school work. A self-evaluation form was provided to help them assess how they were doing in their Mathematics class. A discussion about strategies to remedy low performance was initiated by the facilitator. The value of rewarding oneself when a task is accomplished was taught with the use of the "If-then Contract”. The "If-then contract" made the learners think of the rewards they would like to give themselves under certain conditions. The facilitator guided the learners on emotional control, and called for and rewarded accomplishment rather than simple obedience. But for failure control strategy, learners were encouraged to change ineffective behaviour after unsuccessful attempts and to seek assistance from their peers, parents and teachers. Sessions 15 - 40 were facilitated for the participants to apply the volitional strategies in their Mathematics lessons. During the remaining sessions, learners were guided to monitor and evaluate their own progress with the proper use of volitional strategies by means of a rubric. Each week learners completed forms for goal setting, volitional strategy use and self-evaluation. In each session, the facilitator observed the learners in terms of how they performed during the class activity. An interview report was provided for sampled learners.

In addition, learners were asked to make daily observations and to record the strategies they used to learn Mathematics. Their responses on the Strategy Observation Tool (Appendices A and B), and written reflections will serve as sources of data for examining how the Strategy Observation Tool is functioning. Learners’ responses were examined each successive week.

Phase 3:

The third phase entailed crossing over; this involved application of the learning model experiment to the control group for the period of eight weeks. During this period the experiment group continued with their Mathematics teacher (who had not been instructed on volitional strategy use). In Phase, 3 at the end of Phase 2, both control and experiment groups took a post-test, i.e. wrote the relevant standard Mathematics test (T3) provided by the Moses Kotane APO (NWED), and the VCI survey (68 items). The assessment activity, i.e. the post test and the VCI survey evaluated Mathematics learning and progress, and possible changes in volitional conduct, in order to determine the effect of experimental intervention.

The third phase as well entailed application of mixed methods by crossing over of quantitative means of data collection to qualitative means through interviewing of some sampled learners in the experiment group. The results of assessment provide outcome data related to the impact of the intervention and allow for an on-going formative evaluation of the volition intervention process. As well crossing over of methods was used for comparison and further analysis with interview themes to determine any link between volition strategy use and mathematical achievement.

Phase 4:

In phase 4 the activities in phase 2 were repeated for the control group. The volition self-regulation learner model developed during phase 2 was applied to the control group only in phase 4. The experimental group continued with their Mathematics teacher who did not have much volitional instructional competency. However, the learners having acquired the new strategies with help of the researcher during intervention period were expected to put into practice their acquired volitional strategies for learning Mathematics.

Phase 5:

Phase 5 was the conclusion phase. In this phase the final retention test was conducted with both the control group and the experimental group. Learners from both the control group and the experimental group completed a VCI survey questionnaire and wrote the third Mathematics test.

4.6 QUANTITATIVE RESEARCH

The positivist approach views knowledge as something external to the individual, not based on the meaning an individual assigns it. The positivists believe that knowledge is objective and does not depend on the perception of any one individual. The knowledge that develops through a post-positivist lens is based on careful observation and measurement of the objective reality that exists “out there” in the world (Creswell, 2005:8). Indeed, according to Barnes, (2012:465) positivism suggests that a set of true concepts and causal relationships exist in the world that can be measured and analysed quantitatively. The major characteristics of traditional quantitative research are a focus on deduction, confirmation, theory/hypothesis testing, explanation, prediction, standardized data collection, and statistical analysis (Johnson & Onwuegbuzie, 2004:18). Also Powell, Mihalas, Onwuegbuzie, Suldo, and Daley (2008:305) highlight that quantitative research is useful for identifying prevalence rates (i.e., descriptive research), relationships (i.e. correlational research, causal-comparative, quasi experimental research), and cause-and-effect relationships (i.e. experimental research), which, under certain conditions (e.g., large and random samples), can be generalized from the sample to the population.

One of the goals of the quantitative phase was to identify the potential predictive power of selected variables on the learners’ effort sustenance and Mathematics achievement on application of volition intervention activities. The quantitative data was collected via a volition component cross-sectional survey (Kuhl & Fuhrmann, 1998:26:26), using an instrument first developed by Kuhl and Fuhrmann in 1998 and adapted for Mathematics by Molokoli and Nieuwoudt in 2003. The core survey items formed eight seven-point Likert type scales and reflected the following composite ten variables, representing a range of internal factors: planning, lack of energy, initiating, goal neglect, volitional self-efficacy, intention monitoring, attention control, self-control pressure, emotion control and failure control. The factors were identified through the analysis of the related literature (see par. 2.3 – 2.7), three theoretical models of volition mode of self-regulation, volition control, self-regulation and effort control (Orbell, 2003:97, Turner & Husman, 2008:138; Panadero & Alonso-Tapia, 2014:456). As well, factors were identified in an earlier research study on relationships between volitional strategies’ use, study orientation and mathematics achievement that was conducted in four schools in Rustenburg (Molokoli, 2005).

In this sequential explanatory design, one of the goals of the research study was to develop an initial volition intervention model. Secondly the model had to be statistically evaluated using empirical volitional control and Mathematics performance data. Therefore in this sequential exploratory design, priority was given to the quantitative approach. The quantitative data collection represented the major aspect of the mixed-methods data collection process. The smaller qualitative component followed in the second phase of the research.

There was no specific criteria for selecting participants to take part in the quantitative phase. All 66 Grade 9 learners in school A and 88 learners in school B were incuded thus a total of 154 participants responded to the survey. Thus to both the experimental and control groups 68 items of a survey questionnaire on mathematics learners' volition strategy were used to determine the individual learner volition profile. In the sequential explanatory design, the data were collected over the period of time in two consecutive phases. Thus, the researcher first collected and analysed the quantitative data. Qualitative data were collected in the second phase of the study and were related to the outcomes from the first, quantitative, phase. The decision to follow the quantitative-qualitative data collection and analysis sequence in this design depended on the fact that the study purpose was to develop, implement and evaluate a model to enhance volition strategies use. In order to respond to the research questions (par. 1.3.1) hence the contextual field-based explanation of the statistical results was needed.

The research study, in alignment with Turner and Husman (2008:145), intends to highlight learner need to use volitional strategies to boost own Mathematics achievement. The questionnaire survey was used for analysis and evaluation. Thus the quantitative phase of the study consisted of descriptive analysis (i.e. frequencies) of learners' responses to a 68-item structured questionnaire developed for the study. The quantitative section of these evaluation forms carried the most weight. And the responses to these items were averaged to produce a mean volitional use score. This average was then used as an index of volitional effect (i.e., effect size). The statistical techniques like analysis of variance (ANOVA), partial eta-squared, a three-way and a nested design ANOVA and subjective inferences, were utilised to make decisions in identifying the predictive power of ten selected factors as related to learners' effort sustenance in the volition intervention model. The pre-/post-/retention test and pre-/post-/retention VCI questionnaire were quantitatively analysed with the help of the NWU statistical unit.

4.6.1 Rationale and purpose of quantitative research as in empirical study

The performance of learners before and after treatment (see par 1.3) and their volitional strategies use in Mathematics before and after treatment (see par. 1) were measured quantitatively. The purpose of quantitative approach was to use pre-/post-/retention-test as a means to measure effectiveness of the learning environment treatment for the grade 9 Mathematics learners. The Mathematics test provided valuable information regarding how a teaching model that embraced integration of volitional strategy categories during Mathematics learning influences Mathematics learners' performance in grade 9. The VCI instrument used in the survey provided research with important information with regards to how volition enhancement programme influenced learners' self-monitoring ability in grade 9 Mathematics classrooms.

4.6.2 Population and sample

The population comprised grade 9 learners taking Mathematics, from two selected secondary rural community schools situated in Moses Kotane Area Project Office in North West Education Department. The schools (A and B) were identified as experimental and control groups respectively. The research study target was 154 grade 9 Mathematics learners in two different public secondary schools situated in Rustenburg district of the North West province. Learners from these areas had scored below average Mathematics achievement in previous years' grade 12 results, often struggle to understand Mathematics concepts and completing homework. The researcher is a principal at one school while the other school is situated in the vicinity of the researcher's work place.

4.6.3 Variables

In this research study, the dependent variable was Mathematics learner achievement as reflected by the Mathematics achievement test mark. The independent variables were learner use of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy.

4.6.4 Measurement instruments

The two main types of instruments that were used to evaluate the implementation and effects of the experimental learning environment are outlined below:

Instrument 1 is the VCI questionnaire (Kuhl and Fuhrmann, 1998:26).

The measuring instruments to capture volitional propensity made use of 68 items adapted and selected from Volitional Component Inventory (VCI) by Kuhl and Fuhrmann, (1998:26). This instrument was made up of the domain-specific questions that contained 7 Likert-type scales to assess frequency of learner reported strategy usage as indicated in table 4.2 and Appendix A.

Table 4.2 Response rating on VCI questionnaire

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

In particular learners were expected to estimate their response rating as per 7 Likert-type scales. The responses reported perceived learner meta-volitional strategies use in close connection to six main factors of planning and initiating, intention monitoring, attention control, volitional self-efficacy, failure and emotional control and their technique for regulation of effort in Mathematics lessons (Kuhl & Fuhrmann, 1998:26). Emotional control was indicated by frequency of reported ways in which learners avoid negative emotionality through regulation of affect (Kuhl & Fuhrmann, 2000:678). Attention control indicated reported means by which learners control unwanted impulses and intrusive thoughts whilst in pursuit of learning goals. Failure control was indicated by reported learner reactions to mistakes or failure. Volitional self-efficacy beliefs were a measure of indicated learner self-reflections about volitional competence and efficiency. The Cronbach Alpha coefficients for the VCI scales as used earlier (see Molokoli 2005:107) indicated sufficient internal reliability for most scales.

Instrument 2 (Pre-test, Post-test & Retention-test)

The investigation involved administering written achievement tests, ranking the scores, and then purposively selecting (i.e. extreme sampling) learners who attained scores that were in the top third and bottom third of the score distribution. These learners were then interviewed and asked about their perceptions of volitional strategy use.

The researcher used partial eta-squared analysis for practical significance and to measure the effect size. The responses from the pre-test, the post-test and the retention test, were scrutinized for evidence of learner volition strategy practice using heuristic strategies.

4.6.5 The administration process, learner volition use survey and teacher programme induction

The researcher first sought permission to conduct research in schools from the Bojanala (Rustenburg) District directorate through a letter. When the permission was granted the researcher secured appointments with respective schools principals. There were only two selected schools involved in the research project and the researcher works as principal in one of these schools. An appointment was made with the other principal and affected grade 9 Mathematics educators of both schools to outline description of the research, its aim, objectives and projected timeframe. Schools also granted the researcher permission to conduct research and provided the researcher with all the grade 9 class lists. The researcher invited all registered grade 9 learners in both schools to participate in the research.

During separate meetings with affected educators, the research project with its different phases (see table 4.1) were outlined. A schedule was given to schools principal to clearly indicate when two research instruments, the pre-test and the VCI questionnaire will be conducted (see Annexture1). Specific dates for the pre-test and the VCI questionnaire were given to schools. The researcher informed and issued the outline of learner enhancement volition programme to the affected teachers. The programme also highlighted the need for learner use of volitional strategies during mathematics teaching and learning. The researcher agreed with educators that the standardised tests set by the Moses Kotane East Area Project Office (APO) Mathematics subject specialists would be used as pre-test, post-test and retention tests. The VCI questionnaire was introduced to Mathematics educators who were expected to invigilate and collect the instruments from learners, and requested to submit all data to the researcher. Then the researcher collected all completed VCI and pre-tests at the agreed time. Learners absent on the day tests were taken, were excluded. The collection of data from most learners in all tests ensured a representative database of responses from the study population for quantitative analysis and interpretation. Hence data largely contribute to construction of the volition enhancement model based learning environment.

4.6.6 Reliability

Internal reliability refers to the extent to which a measure is consistent within itself (Fadare, Babatunde, Ojo, Iyanda & Sangogboye, 2011: 218). Reliability is focused on the extent to which responses to survey items are consistent (Etchegaray & Fischer, 2010:133). Reliability estimates that consider item homogeneity, or the degree to which items on a test are internally consistent, are referred to as internal consistency reliability estimates (Nimon, Zientek & Henson, 2012: 7).

4.6.6.1 Internal Consistency Reliability

According to Nimon (2012:2) and colleagues, the internal consistency reliability of a dimension is a measure of how well the dimension is expressed as the sum of the constituent items. They (2012:2) highlight that reliability is calculated by computing the ratio between true score variance and observed score variance. But the nature of educational research means that most, if not all, variables are difficult to measure and yield reliabilities less than 1. The internal consistency reliability for each scale/sub scale is estimated using the Cronbach α coefficient. With assistance of Statistical Consultation Services of NWU (Potchefstroom Campus), internal consistency reliability was assessed by computing coefficient alpha (α; Cronbach, 1951). The estimate of internal consistency benchmarks established in the current research study was aligned in conjunction with Fadare et al., (2011:218). In this regard the scales with reliabilities of ≥0.50–0.70 were considered sufficiently reliable for use in group comparisons.

4.6.6.2 To investigate the internal structure of the VCI

Principal component analysis (PCA) is an underlying factor reduction and is a complex, sequential variable reduction procedure in measuring and evaluating internal consistency of measuring instrument Fadare *et al.*, (2011:218). The quantitative research design involves applying the Principal Components Analysis with varimax rotation to investigate the internal consistency of measuring items of the VCI. Moreover, Fadare et al. (2011:219) emphasize that the goal of PCA is to decompose a data table with correlated measurements into a new set of uncorrelated analysis that is orthogonal variables. These variables are called, depending upon the context, principal components, factors, eigenvectors, singular vectors or loadings. Each unit was assigned a set of scores which corresponded with its projection on the components. The importance of each component was expressed by the variance (i.e. eigenvalues) by the proportion of the variance explained.

4.6.6.3 To determine the Number of "Meaningful" components to Retain

According to Fadare et al. (2011:220), the purpose of PCA is to reduce a number of observed variables into a relatively smaller number of components. A purpose that cannot be achieved if one retains components that account for less variance than has been contributed by individual variables. Hence the next step determines how many meaningful components should be retained for interpretation. Researchers suggest four criteria used in achieving this decision that are namely:

(1) Eigenvalue-one criterion
(2) The screen test
(3) The proportion of variance accounted for
(4) The interpretability criterion

The eigenvalue-one criterion is applied to determine how many factors should be retained. A method retains and interprets any component with an eigenvalue greater than 1. On the other hand, a component with an eigenvalue less than 1.00 is accounting for less variance than had been contributed by one variable. Since several studies show that the 'eigenvalues > 1' rule leads to an overestimation of the number of factors to retain (Henson & Roberts 2006) in the research project to confirm the hypothesised grouping of items into their dimensions, the factor (determined by the PCA loading) has to overlap with the content of the questionnaire dimensions. The number that meets the 'Mineigen criterion eigenvalues > 1.5' determines the number of factors to retain. Secondly, a component is retained if it minimally explains an approximate additional 5% of the variance.

Then again, factor analysis was used to identify the structure underlying subset variables and to estimate scores to measure latent factors themselves (Fadare et al., 2011:219

4.6.6.4 Factor Analysis

Factor analysis is one of the most useful methods for studying and validating the internal structure of instruments (Nunnally 1978; Pedhazur & Schmelkin 1991; Kieffer 1999; Henson & Roberts 2006). Factor analysis with several partial criteria was used to study whether a test measures a postulated "general learning ability." (Cronbach & Meehli, 1955:286).

Factor analysis is a statistical procedure used to uncover relationships among many variables. This allows numerous inter-correlated variables to be condensed into fewer dimensions. In this study factor analysis entailed consideration of the measures taken to promote learning experiences in Mathematics and freely loading them into several factors. Hence factor analysis is a statistical approach whereby groups of similar items were identified and the number of variables in the questionnaire was reduced. Factor analysis provides better understanding of the data. Thus, as Teoh, Koo and Singh (2010:714) assert, factor analysis is an analytical tool for deriving constructs or lantern variables or factors from a set of items. In concurrence

Lutabingwa and Auriacombe, (2007:545) denote that the purpose of factor analysis is to discover simple patterns in the pattern of relationships among the variables. With factor analysis the researcher can produce a small number of factors from a large number of variables which are capable of explaining the observed variance in the larger number of variables. The reduced factors can also be used for further analysis. Moreover, Lutabingwa and Auriacombe (2007:545) suggest that the main applications of factor analytic techniques is to reduce the number of variables; and to detect structure in the relationships between variables. Therefore, factor analysis was applied as a data reduction or structure detection. There were three stages in factor analysis:

- Firstly, a correlation matrix was generated for all the variables. The correlation matrix was a rectangular array of the correlation coefficients of the variables with each other;
- Secondly, factors were extracted from the correlation matrix based on the correlation coefficients of the variables; and
- Thirdly, the factors were rotated in order to maximise the relationship between the variables and some of the factors. Thus factor rotation was used to statistically manipulate (by rotating the factors) the results to make the factors more interpretable, and hence assist in making final decisions about the number of underlying factors.

Table 4.3. Psychometric and interpretability criteria applied in factor analysis.

Objective or psychometric	1	Point of inflexion on the scree plot
	2	Eigenvalues > 1.5
Criteria	3	Proportion of variance accounted for is minimally approximately 5% Interpretability criteria
	4a	At least 3 variables with a loading >0.40 per factor
	4b	Variables of the same component measure the same construct
	4c	Variables loading on different components measure different constructs
	4d	The rotated factor pattern demonstrates simple structure

(Nrock-adema, Heijne-Penninga, Van Hell, & Cohen-Schotanus, 2009:e228).

Factor Analysis Extraction Method

The next decision was the rotation method. Fadare et al.,2011:222) indicate the goal of rotation as being to simplify and clarify the data structure. In addition choices of methods of rotation mentioned were Varimax, quartimax, and equamax which are orthogonal; while some are direct oblique methods which are oblimin, quartimin, and promax. Orthogonal rotations produce factors that were uncorrelated while oblique methods allow the factors to correlate. In agreement with Fadare et al. (2011:222), the orthogonal rotation method was used because it produced more easily interpretable results.

4.7 VALIDITY

Validity is focused on whether the survey items measure what is intended to be measured (Etchegaray & Fischer, 2010:133). Validity studies in the cognitive functions depend on criteria of internal consistency. Reise, Waller, and Comrey (2000:287) elaborate that the term validity is used to imply that a measure (a) has item content and a corresponding factor structure that is representative of and consistent with what is currently known regarding a construct; (b) has a factor structure that is replicable and generalizable across relevant populations, and (c) has a clearly interpretable (i.e. univocal) and relatively precise scaling of individuals along one or more common dimensions.

4.7.1 Construct validity of VCI questionnaire

The current study first examined volition enhancement from a construct-validation perspective. A construct is considered as some postulated attribute of learners, assumed to be reflected in VCI test performance. The constructs that the instrument intended to measure were identified and defined in Chapter 2. Construct validity for this study was assessed by means of confirmatory factor analysis, as described by Van Aardt and Steyn (1991: 47). Etchegaray and Fischer (2010:135) echo that confirmatory factor analysis (CFA) is a statistical test used to gather more evidence for construct validity. It is believed that hypothesized factor structures can be assessed and compared with confirmatory factor analysis (CFA) techniques to address the construct validity question. Hence Confirmatory Factor Analysis (CFA) was performed to determine whether a one-, two, three-, or five-factor solution best fit the VCI items. Each of the personal attribute subscales was subjected to a factor analysis, using principal components for factor extraction.

Van Wyk and Van Aardt (2011:172) mention what Smith, Barnard and Steyn (1988: 20) highlight, viz. that a scale displays good construct validity when one (the ideal) or only a few factors are extracted, which together explain a substantial proportion of the variance, and when high communalities are obtained for each statement. Thus both exploratory factor analysis and final communalities were examined on the responses to the 68 items in the VCI to determine the underlying factor structure. In this regard, Tarn and Coleman, (2009:57) provide standards in concurrence with (Tabachnick & Fidell, 2001), that the greater the extracted communalities, the stronger the suggestion of internal consistency of the factors. Communality is the percentage of variance a variable shares with the common factors on the diagonal (Reise *et al.* 2000:294). A final communality value >0.3 implies (Van Aardt & Steyn, 1991:44; Van der Walt, *et al.*, 2008: 294) acceptable construct validity (Smit, 2009:338).

The researcher ensured reliability by using Cronbach Alpha Coefficients of subscales. Construct validity of the scores was confirmed using Factor Analysis. Analyses of variance (ANOVA) were used to arrive at an answer to the research question. Help was sought from the Statistical Consultation Services of the NWU (Potchefstroom Campus).

4.8 DATA ANALYSIS

In addition, Statistical Consultation Services of the North-West University were consulted to analyse the data, and the statistical programme package (StatSoft Inc., 2013) available on the North-West University network was used to process the data. The data were analysed according to four dependent measures: (a) self- regulation (b) volition control, (c) volition and effort regulation and (d) Mathematics achievement. Self-regulation (volitional self-efficacy and planning and initiating), volition control (intention monitoring, attention control), volition and effort control (self-control pressure and emotion control, self-reflections and failure control) and Mathematics achievement were analysed via 2 x 2 (time) (group) repeated measures ANOVAs (volitional control intervention: presence vs. absence). Effect sizes were computed using partial eta-squared ($ŋ^{2}_{p}$). The pre/post/retention test using VCI instrument and the pre/post/retention Mathematics achievement tests, descriptive and inferential statistical techniques were used to organise, analyse, and interpret the quantitative data.

Inferential Analysis

The ANOVA (Analysis Of Variance) was used as inferential analysis technique. Graphical tests for normality were performed to assure that the assumption of normality holds for ANOVA.

Crossover Analysis Of Variance (ANOVA)

The primary objective was to compare the effect of volitional strategy use during Mathematics learning, as measured by VCI instrument between two periods from pre-test, post-test and retention. The comparison was made by conducting a two-period crossover study. Data used for the crossover ANOVA were from the two subpopulations - a control group and experimental group. The treatment sequence consisted of application of treatment (volition use) in a fixed sequence of periods as indicated in figure 4.3. Both the period effect and the interaction between period and treatment were analysed.

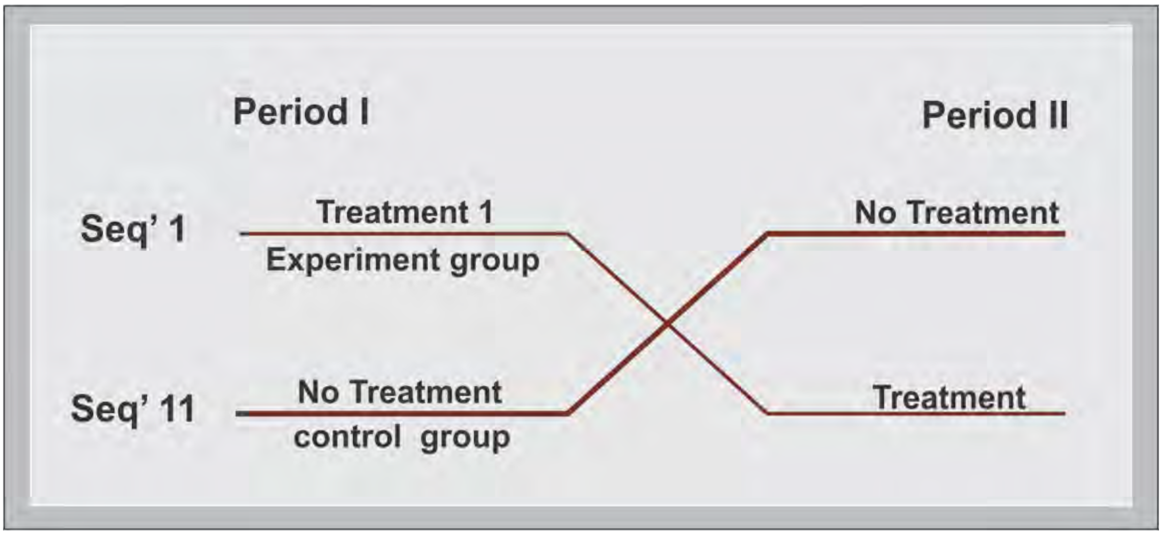


Figure 4. 3 Crossover study design

The analysis approach of the primary objective makes two main assumptions: no period effect and no treatment-period interactions (Berggren, 2012:13). Hence for the analysis in crossover designs, the researcher focused on the effect tests: The test for carryover effect, the test for period effect and the test for treatment effect (Brunelle, 2000:5; Berggren, 2005:13). Brunelle (2000:5) advises that If the carry-over effect is significant, then only Period 1 data can estimate the treatment effect, but If the carry-over effect is not significant then the pooled data from both periods can be used to estimate the treatment effect.

A small p-value ($p<0.05$) indicated sufficient evidence of statistical significance (Ellis & Steyn, 2003:51; Field, 2005:371, 405, Steyn, 2012). A p-value below 0.05 is called significant, p-values below 0.01 were called highly significant, and p-values below 0.001 were called very highly significant (Garth, 2008:53). Where there were no carryover or period effects, variance is considered within subject correlation of responses on treatment (Piantadosi, 2005:517).

The major benefit of the crossover design was that it was able to detect small but statistically significant differences thus make comparison of treatment effects on learners within specified time interval.

The Analysis of variance

In statistical analysis, Lutabingwa and Auriacombe (2007:536) define the variance as the mean of the squared deviations from a distribution's mean. Based on the two-way crossover design, a three-way ANOVA was used to investigate the main effects treatment, period and subjects based on the gain (i.e the difference between measurements after and before treatment) in developed learner ability to recognise use of identified volitional strategy and effect on mathematics performance. In another step an ANOVA with group effect and a subject nested within the group effect was performed to determine whether any of the variables displayed a carry-over effect from the first period (or phase) to the second.

Effect sizes

Effect sizes were reported to describe the magnitude of the change scores between experimental group and control groups, pre- and post-intervention scores for experimental group, and pre- and post-intervention scores for the control groups. Onwuegbuzie and Leech (2004:772) bring to light that the use of effect sizes is to assess the practical significance of a finding, and that effect size represents the educational value of the research result. The term "effect size" is defined by Cohen (1988) as "the degree to which the phenomenon is present in the population" (Steyn & Ellis, 2009:106).

Eta-squared effect size

Another statistical tool used in analysis was the weighted eta-squared effect size (η^2). Eta^2 estimates are referred to as *variance-accounted-for* statistics. The Eta^2 estimates provide a natural generalization of the simple index η^2 and reflect the proportion of total variance accounted for by the effect of treatment, phase, subject or group. Moreover classical eta-squared is used as a descriptive index of strength of association between an experimental factor (main effect or interaction effect) and a dependent variable. Classical eta-squared is defined as the proportion of total variation attributable to the factor, and it ranges in value from 0 to 1 (Pierce, Block & Aguinis, 2004:918). Even Maxwell, Camp and Arvey, (1981:532) documented that eta squared is strictly a descriptive measure which serves to index the degree of association between a dependent variable and an independent variable in a sample. However, Brown (2008:40) warns that the magnitude of eta^2 for each particular effect depends to some degree on the significance and number of other effects in the design. Hence it is advised that use of statistic partial eta^2 minimizes the effects of these problems. Partial eta^2 is defined as the ratio of variance accounted for by an effect, and that effect plus its associated error variance within an ANOVA study (Brown, 2008:40). Even Trusty, Thompson and Petrocelli (2004:108) record partial eta^2 as an estimate of the amount of variance in the dependent variable attributable to particular effect of interest. Bakeman, (2005:380) insinuates that η^2_p is usually presented as a solution to the comparability problem and that in the context of factorial design, η^2_p removes the effect of other factors from the denominator. Moreover, Brown (2008:39) adds that eta^2 can help in interpreting the results by indicating the relative degree to which the variance that was found in the ANOVA was associated with each of the main effects and its interaction.

The following Eta^2-values provide a clear indicator of the effect sizes:

Eta-sq = 0.01: small effect,

Eta-sq = 0.06: medium effect

Eta-sq = 0.14: large effect.

Least square mean (LS)

In order to describe trends and variations of outcome variables comparing both groups, summary statistics were calculated. The least square mean (LS), treatment differences in LS means, and their 95% confidence intervals (CIs) were derived from the ANOVA model. LS mean for each treatment group reflected the within-treatment comparisons between pre-test and post-test time points in the scores.

An analysis of variance test of normality

The test of normality was used as a statistical inference procedure designed to test whether the underlying distribution of a random variable is normally distributed (D'agostino, Belanger, & D'agostino (jr), 1990:316).

A graphical presentation of the test is to plot the ranked data against the expected ranked normal values, and if the points lie approximately on a straight line, the underlying distribution was considered normal.

4.9 QUALITATIVE RESEARCH

Qualitative researchers place a substantial emphasis on how participants in a study make sense or meaning of a situation. Creswell (2005:10) highlights that qualitative researchers make an interpretation of what they find that is shaped by the researchers' own experiences and backgrounds. According to advocates of qualitative research, learners attain knowledge by sensing their world and giving meaning to these senses through socially constructed interactions and discussions (Creswell & Miller 1997:37).

In the qualitative, phase, research techniques that include interviews, participant observations, and document analysis were used to help explain why certain internal factors, tested in the first quantitative phase, were significant or not significant predictors of learners' effort sustenance in the volition intervention model.

The goal of the qualitative phase was to explore and interpret the statistical results obtained in the first, quantitative, phase. In an attempt to determine why the two groups differed on the quantitative measure and to enhance the depth of qualitative analysis, research techniques that include interviews, participant observations, and document analysis were used. These implied extensive and tedious data collection from different sources, as well as multiple levels of data analysis (Onwuegbuzie & Leech (2004:781). For this phase, twelve participants were purposefully selected, new qualitative data are collected from the lowest and highest-scoring groups, from those who completed the survey. In order to provide the richness and the depth of the case description (Schulze, 2003:12) multiple sources for collecting the data were used: (1) in-depth semi-structured interviews with the twelve participants; (2) researcher's reflection notes on each participant's effort sustenance recorded on volition observation tool, and (3) additional information on the emerging themes as revealed on follow-up class discussions.

4.9.1 The purpose with qualitative research

The purpose of the qualitative research was to derive knowledge from what was being interpreted by the participating learner. In this regard Barnes, (2012:465) highlights that since interpretation is the human subjective perceptions and experiences of the social world that matter, multiple versions of reality may exist. In the field, the qualitative researcher gathers information through interviews with learners who are able to tell their stories. The constituted knowledge is based on internal perspectives and meanings provided by specific learners. Creswell and Miller (1997:37) advance that information is obtained inductively through informal interviews and knowledge is established from specific working contexts. Therefore qualitative research is called interpretive research that reports participants' views. And, according to Barnes (2012:465), interpretivism promotes inductive thinking with an 'open mind' to build theories/concepts/relationships from the ground up.

4.9.2 The rationale of qualitative research

Herein the rationale of qualitative research was to gather close information by actually engaging or interacting with, talking directly to learners, and seeing them behave and act within their Mathematics classroom context. The face-to-face interaction with the learners was for the duration of two school terms. In the entire process of this study, the researcher kept the focus on Mathematics learning and the meaning that the learners held about volition strategy use. Furthermore the researcher conducted open-ended learner interviews with best, average and under-performing learners. The rationale behind interviews was to seek a more comprehensive and complete understanding of the phenomenon of volition that propels character of the interactions among learners in the classroom setting. The interviews also determined experiential reasons behind learner completion or non-completion of Mathematics homeworks.

4.9.3 Population and sample

The population embraced grade 9 learners taking Mathematics, from two selected secondary rural community schools situated in Moses Kotane Area Project Office in North West Education Department. The schools (A and B) were identified as experimental and control groups. However, the qualitative research study targeted mainly extreme cases of learners, that is three best performing and three underperforming grade 9 Mathematics learners from each school (A and B). The scores on Mathematics achievement tests were used to identify extreme learner cases. The researcher made use of qualitative technique by applying semi-structured interviews to provide the information on learner volitional strategy deployment.

4.9.4 Data generation

The different instruments used to evaluate the implementation and effects of the experimental learning environment involved field notes, structured interviews and developed volition observation tool.

Observation notes were taken during classes on a continuous basis. The Researcher conducted reflection meetings with learners with intend to highlight both achievements and challenges at the end of each school day. The records of held reflection meetings with researcher and learners were kept. The volition observation tool takes cognisance of the principles that place emphasis on self-assessment to help learners develop the ability to monitor their own understanding, and find resources to deepen the understanding, when necessary (Pellegrino, Baxter, & Glaser, 1999:330). During the intervention sessions, learners were guided to monitor and evaluate their own progress on specific mathematics tasks. As well learners were encouraged to reflect on their progress over time on the proper use of volitional strategies by means of a rubric. Each week learners completed forms for goal setting, volitional strategy use and self-evaluation. In each session, the facilitator observed the learners in terms of how they performed during the class activity. A case report was provided for each learner. Some positive relationships with grade 9 Mathematics teachers and learners were established as well.

4.9.5 Data analysis of qualitative research

The classroom volitional strategy observation tool, field notes and learner record of continuous assessment were analysed using indicators as designed by the researcher. The researcher made use of a thematic analysis on two levels, individual learner and across class group. A general check was made of frequency of each significant statement within each theme, or the frequency of each theme within a set of themes. The themes and categories were compared together with text units (sentences) counts for each theme across the high and low performing groups. The analysis and interpretation of these indicators provided the researcher with valuable information regarding the implementation of volitional strategies.

4.9.6 Trustworthiness

The rationale behind mixing quantitative and qualitative approaches was to enhance treatment integrity. In concurrence with Creswell and Miller (1997), the quantitative study deductively tests volition theory and in-depth qualitative interviewing refines it. Hence the trustworthiness of intervention was assessed by mixing quantitative and qualitative techniques. For the purpose of auditing, all the recordings and notes were kept in a safe place to be accessed at any time on request (Niemann, 2003: 11).

4.10 ETHICAL ASPECTS OF THE RESEARCH

Ethical approval for the study was granted by the North-West University Ethics Committee to conduct research in some schools in South Africa. The ethical aspects involved first obtaining permission from the North West Department of Education, the Bojanala Region, the principal and teachers to be involved, the parents of learners (and the learners) that were selected to conduct research work at two schools in Moses Kotane East Area Project Office. It was further communicated to learners that they had the option to withdraw from the research at any stage if they felt like. The second aspect entailed stating in the letter the purpose of research study as a Post Graduate learner (PhD) that intends to examine the role of learner volition in Mathematics learning. I indicated the aim which is to suggest learning strategies that may be integrated into teaching of Mathematical subjects during investigations enabling learners to improve their decision making, critical and creative thinking ability.

The participating learners were reassured of confidentiality and anonymity so as to protect them from any physical and psychological harm. Furthermore it was clearly communicated that participation was voluntary but we needed them to freely give informed consent about their right to participate and the use of data. It was explained to them that they would be involved in answering written questionnaires, participating in classroom discussions and answering interview questions and that their permission to proceed was required. The participants were informed that feedback of the findings would be made available to them.

Permission was requested from the teachers and from SGB of the participating schools and parents of learners involved in the study (see Appendices B).

4.11 SUMMARY

In this methodological chapter, the researcher described and explained in detail how the empirical study was undertaken. Some focus was placed on mixed method research approach as a methodological framework guided by pragmatism. In addition the following were described and explained to some detail: the mixed method design, the type of design, the rationale and purpose of the design, as well as its strengths and weaknesses. The mixed method approach that best fitted the research project to address the key research aims was sequential explanatory design.

Both quantitative and qualitative methods were described and explained according to rationale and purpose, population and sample, validity and reliability. The methodological process was described (see table 4.1). The chapter ended with important ethical and administrative processes adhered to in the research, in accordance with prescribed standards. The next chapter in the report will provide a detailed description of the statistical data analysis and interpretation and content analysis and interpretation.

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 empirical survey of mathematical learners volition use. The data obtained are processed, recorded and are analysed. The volition intervention programme implemented at schools is outlined. Furthermore data are interpreted and the statistical techniques used in the research are described. Finally the results are discussed

5.2 QUANTITATIVE ANALYSIS OF GRADE 9 MATHEMATICS LEARNERS' USE OF VOLITION

The research study report is based on the following independent variables that are believed to be of significance during Mathematics learning. The independent variables are named as learner use of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy. Moreover, these variables impact on the dependent variable which is Mathematics performance, and are assumed to be reflected in test measurements. The measurement of effect of independent variables on dependent variables during Mathematics learning can be carried out by means of quantitative or qualitative method or a combination of both methods.

5.2.1 Statistical Techniques

The statistical techniques like analysis of variance (ANOVA) were utilized to make decisions about how to answer research questions. The pre-/post-/retention test and pre-/post-/retention VCI questionnaire were quantitatively analysed with the help of the Statistical Consultation Services of NWU (Potchefstroom Campus).

5.2.1.1 *Reliability of instruments*

Nimon *et al*. (2012:6) make an assertion that reliability affects the magnitude and statistical significance of sample statistics. Therefore it is important for researchers to assess the reliability of their data. Reliability is focused on the extent to which responses to survey items are consistent. The estimate of internal consistency benchmarks established in the current research study was aligned in conjunction with Fadare *et al.,* (2011:218) who suggest that the scales with reliabilities of ≥0.50–0.70 are to be considered sufficiently reliable for use in group comparisons. Table 5.1 indicates VCI fields and Cronbach's Alpha values for pre-test, post-test and retention.

Table 5.1 – Cronbach's Alpha for VCI fields

VCI Field	Cronbach Coefficient Alpha		
	Pre-Test	Post-Test	Retention
Intention monitoring	0.47	0.53	0.65
Energy usage, planning and initiating ability	0.77	0.69	0.77
Attention control	0.58	0.74	0.81
Self-control pressure	0.57	0.61	0.54
Volitional self-efficacy	0.53	0.63	0.72
Emotion control	0.62	0.56	0.69
Failure control	0.67	0.58	0.66

Table 5.1 indicates Cronbach Alpha values > 0.5, thus this is evidence that the VCI questionnaire was reliable for the sample used in pre/post/retention phases and in all the different VCI Fields. The accepted Cronbach Alpha coefficient values in the pre VCI test range between a minimum of 0.47 for intention monitoring, and maximum of 0.77 for planning and initiating, while for the post tests alpha coefficients ranged from 0.53 for intention monitoring to 0.74 for attention control. And for retention VCI test alpha coefficients ranged from 0.54 for self-control pressure and 0.81 for attention control. For VCI fields as used in the survey, the Cronbach Alpha values indicated some good reliability.

5.2.1.2 Construct validity

In order to validate the VCI instrument a combination of several psychometric criteria in factor analysis was employed. The criteria included use of eigenvalues and minimum percentage of additionally explained variance (approximately 5%). The eigenvalues criterion applied involved the 'eigenvalues > 1' rule that leads to the number of factors to retain (see par. 4.5.6). The interpretability of the resulting factor solutions which seem best according to the psychometric criteria was investigated. It was also investigated whether the outcome of factor analysis was related to the original scale of the VCI. Table 5.2 indicates factor analysis and final communalities

Table 5.2 Table on factor analysis and final communalities

VCI Field	Phase	Number of factors extracted	Total Variance explained by extracted factors)	Range of final Communalities
Self-Control Pressure	Pre Phase	2	44.96%	0.27 – 0.61
	Post Phase	2	53.76%	0.38 – 0.66
	Retention Phase	2	59.35%	0.39 – 0.73
Intention monitoring	Pre Phase	2	53.12%	0.45 – 0.68
	Post Phase	3	52.93%	0.31 – 0.68
	Retention Phase	2	59.03%	0.41 – 0.77
Lack of energy, planning & initiating	Pre Phase	7	59.45%	0.46 – 0.80
	Post Phase	7	61.04%	0.44 – 0.73
	Retention Phase	7	60.13%	0.54 – 0.78
Attention Control	Pre Phase	2	53.48%	0.35 – 0.86
	Post Phase	2	54.74%	0.43 – 0.66
	Retention Phase	1	47.47%	0.38 – 0.58

VCI Field	Phase	Number of factors extracted	Total Variance explained by extracted factors)	Range of final Communalities
Volitional Self-efficacy	Pre Phase	3	60.30%	0.42 – 0.78
	Post Phase	3	46.90%	0.22 – 0.65
	Retention Phase	2	54.46%	0.43 – 0.66
Emotion Control	Pre Phase	2	47.98%	0.35 – 0.60
	Post Phase	2	46.16%	0.33 – 0.60
	Retention Phase	1	35.32%	0.22 – 0.55
Failure control	Pre Phase	2	46.34%	0.34 – 0.73
	Post Phase	3	56.22%	0.38 – 0.73
	Retention Phase	3	57.03%	0.26 – 0.78

VCI scale: self-control pressure.

In the VCI questionnaire the field of self-control pressure comprised seven items (see Appendix C), which have bearing on self-discipline and self-management with regard to Mathematics learning (see par 3.10). Participants responded to 100% of the items. From the table 5.2 it is evident that the number of factors extracted for self-control pressure are two across the pre-/post and retention phase, which indicates more than one underlying construct throughout. The total percentages of variance explained by the extracted factors were 44.96%, 53.76% and 59.35% which was not too low. The final communality values for VCI scale of self-control pressure across the three phases range from 0.27 to 0.61. According to Smith, Barnard and Steyn (1988: 20), a scale displays good construct validity when one (the ideal) or only a few factors are extracted, which together explain a substantial proportion of the variance and when high communalities are obtained for each statement. The final communality value is larger than 0.3, which implies that all items were part of the factor structure.

VCI scale: intention monitoring

The VCI scale of intention monitoring comprises eight items (see Appendix C), which have bearing on intention monitoring, avoidance of being forgetful and persistent reminders when involved with the learning of Mathematics (see par. 3.10). In the scale of intention monitoring a maximum of three factors were extracted for each of the pre-/post and retention phase. This indicated more than one underlying construct. The total percentages of variance explained were 53.12%, 52.93% and 59.03% for each of the pre-/post and retention phase respectively, which indicated an acceptable construct. The final communality for the pre-VCI scale of intention monitoring ranged from 0.45 to 0.68. The final communality for the post-phase of intention monitoring scale ranged from 0.31 to 0.68, while for the retention VCI scale phase communality ranged from 0.41 to 0.77. The final communality value was larger than 0.3 for all the phases, which implied acceptable communality and acceptable construct validity for the intention monitoring scale.

VCI scale: Lack of energy, planning & initiating

There were 21 items in the VCI questionnaire which focused on lack of energy, planning and ability to initiate scale (see appendix C). These included planning ability, active mental force, lack of driving force, timely inspired planning, initiating, considering steps and prompt response (see par. 3.10). From table 5.2 above it is evident that seven factors were extracted for pre-, post- and retention phases. The total percentage variance explained by the extract factors was 59.45% for pre phase, 61.04% for post phase, and 60.13% for retention phase. Hence the extracted sub-factors together explained a substantial proportion (59.45-61.04%) of the total variance for each of the subscales. The final communality ranged from 0.46 to 0.80 for the pre-phase; 0.44 to 0.73 for post and 0.54 to 0.78 for the retention phase. Moreover the final communality value was larger than 0.3 for all the phases thus the factor analysis for this instrument complies to a large extent with the requirements for good construct validity. In view of the seven factors extracted one cannot claim satisfactory construct validity in the case of energy usage, planning and initiating ability: hence in discussion each will be treated independently.

VCI scale: Attention Control

The VCI scale of attention control comprised seven items (see Appendix C), which have bearing on lack of concentration and wandering mind when involved with the learning of Mathematics (see par. 3.10). In the scale of attention control a maximum of two factors were extracted for each of the pre-/post and retention phase. This indicated more than one underlying construct. The total percentages of variance explained were 53.48%, 54.74% and 47.47% for each of the pre-/post and retention phases respectively, which indicated an acceptable construct. The final communality for the pre-VCI scale of attention control ranged from 0.35 to 0.86. The final communality for the post-phase of intention monitoring scale ranged from 0.43 to 0.66, while for the retention VCI scale phase communality ranged from 0.38 to 0.58. The final communality value was larger than 0.3 for all the phases, which implied acceptable communality and acceptable construct validity for the attention control scale.

VCI scale: Volitional Self-efficacy

The VCI scale of volitional self-efficacy comprised seven items (see Appendix C), which had bearing on belief in one's own ability to complete task and reach goal and sense of personal power when involved with the learning of Mathematics (see par. 3.10). In the scale of volitional self-efficacy a maximum of two factors were extracted for each of the pre-/post and retention phase. This indicated more than one underlying construct. The total percentages of variance explained were 60.30%, 46.90% and 54.46% for each of the pre-/post and retention phase respectively, which indicated an acceptable construct. The final communality for the pre-VCI scale of self-efficacy ranged from 0.42 to 0.78. The final communality for the post-phase of volitional self-efficacy scale ranged from 0.22 to 0.65, while for the retention VCI self-efficacy scale phase, communality ranged from 0.43 to 0.66. The final communality values were larger than 0.3 for most of the phases, which implied acceptable communality and acceptable construct validity for the volition self-efficacy scale.

VCI scale: emotional control

The VCI scale of emotional control comprised seven items (see Appendix C), which had bearing on mood management and ability to cheer up when involved with the learning of Mathematics (see par. 3.10). In the scale of emotional control a maximum of two factors were extracted for each of the pre-/post and retention phase. This indicated more than one underlying construct. The total percentages of variance explained was 47.98%, 46.16% and 35.32% for each of the pre-/post and retention phase respectively, which indicated an acceptable construct. The final communality for the pre-VCI scale of emotional control ranged from 0.35 to 0.60. The final communality for the post-phase of emotional control scale ranged from 0.33 to 0.60, while for the retention VCI emotional control phase communality ranged from 0.22 to 0.55. The Final communality value was larger than 0.3 for most of the phases, which implied that communality and construct validity was acceptable for the emotional control scale.

VCI scale: Failure control

The VCI scale of failure control comprised eight items (see Appendix C), which had bearing on quickness to learn from criticism: learning from mistakes and having no time to learn from mistakes when involved with the learning of Mathematics (see par. 3.10). In the scale of failure control a maximum of three factors were extracted for each of the pre-/post and retention phase. This indicated more than one underlying construct. The total percentages of variance explained were 46.34%, 56.22% and 57.03% for each of the pre-/post and retention phase respectively, which indicated an acceptable construct. The final communality for the pre-VCI scale of failure control ranged from 0.34 to 0.73. The final communality for the post-phase of failure control scale ranged from 0.38 to 0.73, while for the retention VCI failure control phase communality ranged from 0.26 to 0.78. The final communality values were larger than 0.3 for most of the phases, which implied that communality and construct validity were acceptable for the failure control scale

5.2.1.2.1 Discussion of the validity and reliability

Whether the concept of learner volition use contributes to research in Mathematics learning depends in part on the construct validity of its measure. In this study where a construct was of central concern, the VCI instrument used was examined. It was determined whether the instrument was a reasonable measure of volition self-management programme effectiveness. If the instrument was of reasonable measure it was argued that it should, within itself, behave consistently with theoretical expectations. Smith *et al*. (1988: 20) highlight that a scale displays good construct validity when one (the ideal) or only a few factors are extracted, which together explain a substantial proportion of the variance and when high communalities are obtained for each statement. Communality is the percentage of variance a variable shares with the common factors on the diagonal (Reise *et al.* 2000:294). Tarn and Coleman (2009:57) provide the standard that the greater the extracted communalities, the stronger the suggestion of internal consistency of the factors.

In the VCI questionnaire used, the six fields were of self-control pressure, intention monitoring, planning, initiating ability and energy usage, volitional self-efficacy, emotion control and failure control. For all the fields, the final communality values were larger than 0.3 for most of the phases, which implied acceptable communality and acceptable construct validity for the VCI questionnaire. Therefore any distinction between the merit of the test and criterion variables was justified since it was shown that Kuhl and Fuhrmann's, (1998:26) theory of volitional action and operations in the inventory component were excellent measures of the attribute.

5.2.1.2.2 Test of normality

The tests of normality were statistical inference procedures designed to test whether the underlying distribution of learner VCI scores for random variables, self-control pressure, intention monitoring, energy usage, planning and initiating ability, volitional self-control, emotion control and failure control were normally distributed. The plotted graphs of within-cells residuals for self-control pressure, intention monitoring and mathematics tests are indicated in figures 5.1 to 5.3.

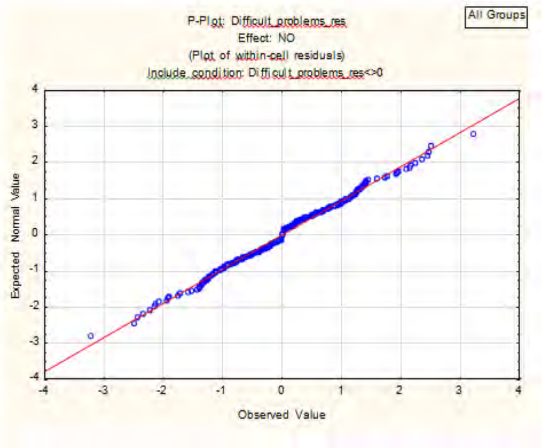


Figure 5.1 Plot of within-cells residuals for self-control pressure

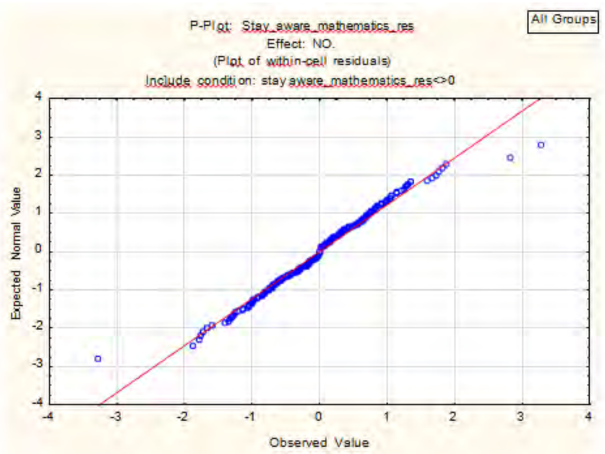


Figure 5.2 Plot of within cells residuals for intention monitoring

In addition figure 5.8 indicates normality check performed over the Mathematics test scores. It was determined whether the underlying distribution of learner Mathematics test scores for dependent variable was normal.

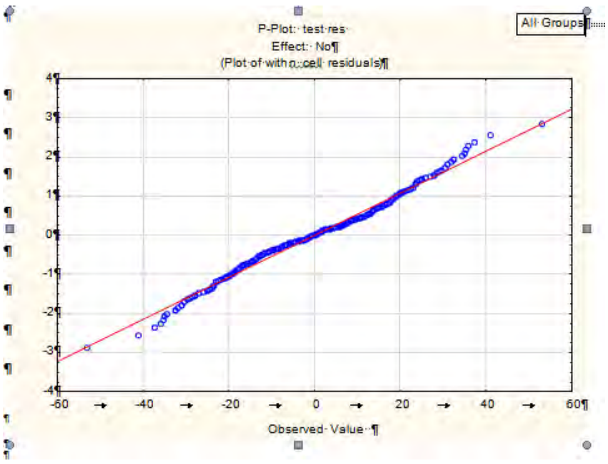


Figure 5.3 Mathematics tests plot of within-cell residuals

For all the figures 5.1 - 5.3 the linearity of plotted graphs indicates that the residuals of the ANOVA-models behaved reasonably like samples from a normal distribution with least square means.

5.2.2 The pre–, post- and retention test data analysis and interpretation

One of the key aims of this research project was to determine how application of the developed model influenced learner achievement in grade 9 Mathematics classrooms (see par 1. 4 d). There were two sub-questions derived from the research aim (see par 1. 4 b & 4 c), that guided the pre-/post-/retention-test analysis.

The learners wrote three relevant standard Mathematics tests (T1, T2 &T3) provided by the Moses Kotane Area Project Office (NWDoE), and responded to the VCI survey (68 items). The items were compiled from six subscales in accordance with key volitional strategy. The tests were given to both experimental and control group learners (see par 4.5). The Mathematics tests provided valuable information regarding how a teaching model that embraced integration of volitional strategy categories during Mathematics learning influences Mathematic learners' performance in grade 9.

To examine the group equivalence before the treatment group interacted with the volitional control support, one-way ANOVAs were performed to investigate the difference between the treatment and control groups in dependent variables using pre-survey responses and first exam scores. The results indicated that there was no initial difference between the two groups: self-control pressure, $F(1,115) = 34.84$ ($p = 0.00$) and $F(1,115) = 1.13$ ($p > 0.05$), intention monitoring, $F(1,116) = 1.42$ ($p = 0.24$) and $F(1,116) = 1.96$ ($p > 0. 05$), lack of energy, planning and initiating $F(1, 124) = 7.002$, ($p = 0.01$) and $F(1, 124) = 0.018$, ($p > 0.05$), attention control, $F(1, 114) = 3.973$, ($p = 0.049$) and $F(1, 114) = 0.024$, ($p > 0.05$), volitional self-efficacy, $F(1,107) = 2.226$ ($p = 0.139$) and $F(1,107) = 0.160$ ($p > 0.05$), emotion control, $F(1, 112) = 0.249$ ($p = 0.619$) and $F(1, 112) = 0.571$ ($p > 0.05$) failure control $F(1, 95) = 4.023$ ($p = 0.049$) and $F(1, 95) = 0.502$ ($p > 0.05$) and achievement $F(1, 153) = 4.59$ ($p = 0.033$) and $F(1, 155) = 0.030$ ($p >0.05$). To address research questions, the repeated measures ANOVAs were performed and the results are presented in Appendix B tables 5.3 – 5.10.

5.2.2.1 Comparison of the control group and experimental group in pre - / post - and retention test for volitional strategy use

The following analysis attempts to provide answers to the sub-question stating: Can learners' Mathematics- related volitional use be enhanced through an educational intervention in an innovative learner view on self-regulation? The pre-, post-, and retention test results were used to compare the experiment and control groups with regard to volition use. ANOVA yielded results as indicated in Appendix B tables 5.3(a) to 5.10(b) for eight variables, namely intention monitoring, attention control, self-control pressure, energy usage, planning and initiating ability, volitional self-efficacy, emotion and failure control and Mathematics tests.

The analysis of variance (ANOVA) was used to compare the impact of identified volition strategy on a continuous response variable in order to determine whether differences exist among the treatment groups. The analysis involved making use of Univariate Tests of Significance, Effect Sizes, and Powers where partial eta^2 values are involved. Brown (2008:39) advises that interpretation of partial eta^2 value is done by moving the decimal point two places to the right in each case, and interpret the results as percentages of variance associated with each of the main effects, the interaction, and error.

Gain in self-control pressure

In ANOVA analysis the F value is the ratio produced by dividing the variance between treatments by variance within subjects and variance expected by chance/error. F value tests how well the intervention as a whole (adjusted for the mean) accounts for the dependent variable's behavior. With respect to self-control pressure in Appendix B (table 5.3) the evidence is that the pre-test value of $p = 1.00$ is the same for both experiment and control groups. For the experiment group the period effect with $F(1,115) = 34.84$ ($p = 0.00$) indicated high statistical significance ($p < 0.05$, at 1 degree of freedom and error of 115). However the post-test value of $p = 0.39$ for the self-control treatment effect suggest there was no statistical significance and therefore no carry-over effects. The results had $F(1,115) = 0.76$ ($p = 0.39$) ($p > 0.05$, at 1 degree of freedom and error of 115) for self-control pressure therefore there was no statistically significant carry-over effect (Brunelle, 2000). The pooled data from both period 1 and period 2 were used to estimate the intervention effect.

For the control group the intervention effect for self-control pressure field had $F(1, 115) = 1.13$ ($p = 0.29$). The implication was that the effect was not of any statistical significance ($p > 0.05$, at 1 degree of freedom and error of 115) for self-control pressure.

At this point reference is made to Eta^2 estimates that are referred to as variance-accounted-for statistics. The interpretation of a partial eta^2 value of 0.42 for self-control pressure is in regard to effect size, 42% of the variability in Mathematics subject differences. It is the variance that is believed to be explained or predicted with knowledge of experimental group on self-control pressure. This however is moderate percentage of variance explained. The variance for period effect is at 23%. However the partial eta-squared for self-control pressure intervention group indicates 1% variance while for the control group it is 0.6%. The eta^2 value of 0.01 was of small effect size.

Gain in intention monitoring

The evidence for results of intention monitoring in Appendix B (table 5.4) is that the pre-test value of $p = 0.99$ is the same for both experiment and control groups. Furthermore, for the experiment group the period effect of $F(1,116) = 1.42$ ($p = 0.24$) indicated no statistical significance ($p > 0.05$, at 1 degree of freedom and error of 116); therefore, in accordance with Brunelle, (2000) there was no statistically significant carry-over effect. However the post-test value of $p = 0.09$ for intention monitoring treatment effect implied that the effect was nearly statistically significant (p almost = 0.05, at 1 degree of freedom and error of 116). The results had F(1,116) = 2.89 for intention monitoring.

The results for the control group for intention monitoring intervention effect are as follows: F(1, 116) = 1.96, (p = 0.16) which implied no statistically significant effect ($p > 0.05$, at 1 degree of freedom and error of 116) for this scale. But reference to Eta^2 estimates as variance-accounted-for statistics gives partial eta^2 value of 0.42 for intention monitoring. In regard to effect size this is 42% of the variability (or differences) in Mathematics scores. It is the variance believed to be explained with knowledge of experimental group on intention monitoring. This is moderate percentage of variance explained. In addition the partial eta-squared = 0.02 indicated that 2% of the between subjects variance is accounted for by enhanced intention monitoring treatment plus Error of 116. This is in comparison to 1% of the control group. The eta^2 value of 0.02 was of small effect size.

Benefit in learner energy usage, planning and initiating ability

The evidence for results for energy usage, planning and initiating ability in Appendix B (table 5.5) is that the pre-test value of p = 0.99 is the same for both experiment and control groups. For the experiment group with regard to learner energy usage, planning and initiating ability the period effect of F(1, 124) = 7.002, p = 0.01 which indicate high statistical significance ($p < 0.05$, at 1 degree of freedom and error of 124). However the value of p = 0.15 for the post-test treatment effect suggests there was no statistical significance and therefore no carry-over effects. The results had F(1,124) = 2.07 (p = 0.153) ($p > 0.05$, at 1 degree of freedom and error of 115) for learner energy usage, planning and initiating ability. The pooled data from both period 1 and period 2 were used to estimate the intervention effect of learner energy usage, planning and initiating ability.

On the other hand reference to Eta^2 estimates as variance-accounted-for statistics gives partial eta^2 value of 0.33 for learner energy usage, planning and initiating ability. In regard to effect size this is 33% of the variability (or differences) in Mathematics scores. It is the variance believed to be explained with knowledge of experimental group on learner energy usage, planning and initiating ability. This is a small percentage of variance explained. But for the treatment group the power statistics of 0.75 were nearer to 0.80, and this was sufficient power to detect some effects (Brown, 2008:38). The partial eta-squared = 0.053 indicated that 5.3% of the between subjects variance is accounted for by enhanced energy usage, planning and initiating ability treatment and interaction plus Error of 124. In addition the partial eta-squared = 0.016 indicated that 1.6% of the between subjects variance is accounted for by enhanced energy usage, planning and initiating ability treatment plus Error of 124. This is in comparison to 0% of the control group. The eta^2 value of 0.016 was of small effect size.

Improvement in attention control

Table 5.9 in respect of attention control provides evidence in Appendix B of the pre-test value of $p = 0.90$ and $p = 0.97$ respectively for experiment and control groups. In addition retention test results for the experiment group indicate the period effect of $F(1, 114) = 3.973$, $p = 0.049$ which indicates statistical significance (p almost = 0.05, at 1 degree of freedom and error of 114). But the post-test attention control treatment effect results show $F(1, 114) = 3.33$ and $p = 0.071$ (p value near to 0.05, at 1 degree of freedom and error of 114) for learner attention control. The results suggest intervention effect for learner attention control.

Some reference to Eta^2 estimates as variance-accounted-for statistics gives partial eta^2 value of 0.477 for learner attention control. In regard to effect size this is 47.7% of the variability (or differences) in Mathematics scores. It is the variance believed to be explained with knowledge of experimental group on learner attention control. This is some moderate percentage of variance explained. And for the treatment group the power statistics of 0.95 were more than 0.80 and had sufficient power to detect some effects (Brown, 2008:38). The partial eta-squared = 0.034 indicated that 3.4% of the between subjects variance was accounted for by enhanced attention control treatment and interaction plus error of 114. In addition the partial eta-squared = 0.028 indicated that 2.8% of the between subjects variance was accounted for by enhanced attention control treatment plus Error of 114. This is in comparison to 0% of the control group. The eta^2 value of 0.028 was of small effect size.

Intervention enhances volitional self-efficacy.

The evidence from results for volitional self-efficacy in Appendix B (table 5.6) is that the pre-test value of $p = 0.99$ was the same for both experiment and control groups. In table 5.6 retention test result evidence for the experiment group in respect of volition self-efficacy reveals that a highly statistically significant period effect existed with a value of $p = 0.033$ (at 1 degree of freedom and error of 107). But the post-test results for volitional self-efficacy intervention effect had $F(1,107) = 2.226$ ($p = 0.139$) which implied that the effect was not of any statistical significance ($p > 0.05$, at 1 degree of freedom and error of 107). However the value of $p = 0.139$ for the treatment effect suggests there was no statistical significance and therefore no carry-over effect. The pooled data from both period 1 and period 2 were used to estimate the intervention effect of learner volitional self-efficacy.

The results for the control group for learner volitional self-efficacy had $F(1,107) = 0.160$ ($p = 0.690$) which implied that the effect was not of any statistical significance ($p > 0.05$, at 1 degree of freedom and error of 107) for learner volitional self-efficacy.

But, reference to Eta^2 estimates as variance-accounted-for statistics, gives partial eta^2 value of 0.37 for learner volitional self-efficacy. In regard to effect size this is 37% of the variability (or differences) in Mathematics scores. It is the variance believed to be explained with knowledge of experimental group on learner volitional self-efficacy. This is a small percentage of variance explained. In addition the partial eta-squared = 0.023 indicated that 2.3% of the between subjects variance is accounted for by enhanced volitional self-efficacy treatment plus Error of 107. This is in comparison to 0.1% of the control group. The eta^2 value of 0.023 was of small effect size.

No gain in emotion control.

The evidence for results for emotion control in Appendix B (table 5.7) is that the pre-test value of $p = 0.99$ is the same for both experiment and control groups. Table 5.7 provides evidence that for the retention test with the experiment group the period effect of $F(1, 112) = 0.571$ ($p = 0.451$) indicated no statistical significance ($p > 0.05$, at 1 degree of freedom and error of 112); therefore there was no statistically significant carry-over effect. The pooled data from both period 1 and period 2 were used to estimate the intervention effect of learner emotion control.

Furthermore the post-test results suggest that the intervention effect for learner emotion control had $F(1,112) = 0.101$ ($p = 0.751$) which implied that the effect was not of any statistical significance ($p > 0.05$, at 1 degree of freedom and error of 112) for learner emotion control.

However reference to Eta^2 estimates as variance-accounted-for statistics gives partial eta^2 value of 0.42 for emotion control. In regard to effect size this is 42% of the variability (or differences) in Mathematics scores. It is the variance believed to be explained with knowledge of experimental group on learner emotion control. This is a small percentage of variance explained. In addition the partial eta-squared = 0.001 indicated that 0.1% of the between subjects variance was accounted for by enhanced emotion control plus Error of 112. This is in comparison to 0.3% of the control group. But partial eta-squared value of 0.001 for intervention group was of no effect size.

Nil effect on failure control

With respect to failure control in Appendix B (table 5.8) the evidence is that the pre-test value of $p = 0.99$ was the same for both experiment and control groups. Table 5.8, retention test for the experiment group for failure control, shows the period effect of $F(1, 95) = 4.023$ ($p = 0.049$) indicating statistical significance ($p < 0.05$, at 1 degree of freedom and error of 95). However, $p = 0.987$ for post-test intervention on how to control failure results indicated no statistical significance. The results were $F(1,95) = 0.000$ ($p > 0.05$, at 1 degree of freedom and error of 95) for learner failure control hence there were no carry-over effects. The pooled data from both period 1 and period 2 were used to estimate the intervention effect of learner failure control.

Reference to Eta^2 estimates as variance-accounted-for statistics gives partial eta^2 value of 0.45 for failure control. In regard to effect size this is 45% of the variability (or differences) in Mathematics scores. It is the variance believed to be explained with knowledge of experimental group on learner failure control. This is moderate percentage of variance explained. In addition the partial eta-squared = 0.000 indicated that only error of 95 accounted for between subjects variance and not by enhanced failure control. This is in comparison to 0.3% of the control group. In addition, the partial eta-squared = 0.000 for intervention group suggests no effect.

5.2.2.1.1 Deduction about learner views on Mathematics related volition use and educational intervention on self-regulation in response to research question 1

Can learners' Mathematics- related volitional use be enhanced through an educational intervention in an innovative learner view on self-regulation?

An assertion was made stating that an educational intervention will enhance Mathematics related volitional strategies use. Undeniably the results revealed that learner perceptions reflected by the partial eta-squared indicated that 1.6% of the between subjects variance was accounted for by enhanced energy usage, planning and initiating ability treatment in comparison to 0% of the control group. The eta^2 value suggests small effect size difference. Definitely evidence gathered is in favour of the assertion made. The intervention enhanced Mathematics related volitional strategy use involving learner energy, planning and initiating ability.

Secondly the partial eta-squared value revealed that 2.3% of the between subjects variance was accounted for by enhanced volitional self-efficacy treatment. This is in comparison to 0.1% of the control group. The eta^2 value was of small effect size. The results endorse that the learner perceptions with regard to the use of volitional self-efficacy are of significant impact.

Hence the contention that intervention enhanced learner strategy use of volitional self-efficacy is upheld.

Thirdly, with regard to improved learner attention control, the partial eta-squared indicated that 3.4% of the between subjects variance was accounted for by enhanced attention control treatment and interaction. The variance was in comparison to the partial eta-squared of 2.8% observed in the control group. Results for attention control intervention group with the power statistics of 0.95 were above 0.80 and had sufficient power to detect some effects. The observed partial eta^2 value suggested effect size of 47.7% for learner heightened attention control as opposed to 37% for the control group with no intervention. Therefore the intervention enhanced learner volitional strategy use involving attention control.

The partial eta-squared indicated that 0.1% of the between subjects variance was accounted for by enhanced emotion control. This is in comparison to 0.3% of the control group. Therefore the intervention had some negative effect on learner volitional strategy use involving emotion control

But with regard to failure control, the partial eta-squared indicated 0%, no variance accounted for by enhanced failure control. This is in comparison to 0.3% of between subjects accounted for in the control group. However for intervention group, with awakened failure control the power statistics of 0.827 were above 0.80 with sufficient power to detect some effects. The partial eta^2 value of 0.451 for learner failure control was detected suggesting effect size of 45.1% of the variability (or differences) in scores as variance-accounted-for by awakened failure control. This is in comparison to 44% of variance for the control group. In this regard the minute difference does not reflect much about observed failure control.

The interpretation for self-control pressure in regard to effect size, 42% of the variability (or differences) in test scores, is believed to be explained with knowledge of experimental group on self-control pressure. The variance is in comparison to 37% predicted in the control group. Therefore the intervention enhanced learner volitional strategy use involving self-control pressure.

The partial eta-squared indicated that 2% of the between subjects variance was accounted for by enhanced intention monitoring. This is in comparison to the variance of 1% of the control group. The intervention enhanced learner volitional strategy use involving intention monitoring to some small extend.

5.2.2.2 The LS means Crossover t-test

The LS mean for each treatment group reflects the within-treatment comparisons between pre-test and post-test time points in the scores. The LS mean values of the experimental and control groups from baseline (pre-test) in period 1 scores prior to treatment and following treatment (post-test) were compared to those in period 2. The criterion used is that reduction in mean value between period 1 and 2 significantly favours intensified volitional strategy use. Tables 5.11 to 5.18 indicate L S means to display LS means crossover t-tests for eight variables.

5.2.2.2.1 Comparison between experiment and control groups' self-evaluation of their own effort management and self-regulation in Mathematics in pre- / post – and retention tests.

In order to fully respond to research question 2 a two-period crossover study involving LS means for volition self-efficacy, self-control pressure, emotion control and failure control was used.

The LS mean differences at week 8 post-test date between intensified volitional self-efficacy experiment and control group reduced from baseline in period 1 (0.249; 95%; CI; -0.001, 0.499), p=0.033 and period 2 (0.188; 95% CI; -0.062, 0.432), p=0.139. The reduction significantly favoured intensified volitional self-efficacy as shown in table 5.11.

Table 5.11. LS Means (crossover data) for volition self-efficacy (VSE)

Cell no	Phase	Volition self-efficacy Mean	Volition self-efficacy Std.Err.	Volition self-efficacy -95.00%	Volition self-efficacy +95.00%	N
1	1	0.249	0.126	-0.001	0.499	122
2	2	-0.147	0.126	-0.397	0.103	117

Cell no	Treatment	Volition self-efficacy	Volition self-efficacy	Volition self-efficacy	Volition self-efficacy	N
1	Yes	0.188	0.126	-0.062	0.438	120
2	No	-0.086	0.127	-0.337	0.165	119

The results of mean values of the emotion control scores prior to treatment and following non-treatment as compared with LS means t-test are shown in table 5.12.

Table 5.12. LS Means (crossover data) for emotion control

Cell no	Phase	Emotion control res Mean	Emotion control res	Emotion control res	N
1	1	-0.053	-0.296	0.190	119
2	2	-0.138	-0.365	0.088	124
1	Yes	-0.123	-0.359	0.113	120
2	No	-0.068	-0.302	0.166	123

The results of mean values of the failure control scores prior to treatment and following non-treatment as compared with LS means t-test are shown in table 5.13.

Table 5.13. LS Means (crossover data) for failure control

Cell no	Phase	Failure control res	Failure control res	Failure control res	Failure control res	N
1	1	0.127	0.115	-0.102	0.356	109
2	2	-0.202	0.111	-0.422	0.018	110

Cell no	Treatment	Failure control res	Failure control res	Failure control res	Failure control res	N
1	Yes	-0.039	0.114	-0.265	0.187	108
2	No	-0.036	0.112	-0.259	0.187	111

The results of mean values of self-control pressure scale scores prior to treatment and following non-treatment as compared with LS means t-test are shown in table 5.14.

Table 5.14. LS Means (crossover data) for self-control pressure scale

Cell no	Phase	Self-control pressure	Self-control pressure	Self-control pressure	Self-control pressure	N
1	1	0.949	0.131	0.689	1.209	122
2	2	-0.128	0.122	-0.369	0.113	127

Cell no	Treatment	Self-control pressure	Self-control pressure	Self-control pressure	N
1	Yes	0.489	0.239	0.741	123
2	No	0.331	0.080	0.581	126

5.2.2.2.1.1 Deduction about effects of volitional self-efficacy, self-control pressure, emotion and failure control in response to research question 2

Can learners' self-evaluation of their own effort management and self-regulation in Mathematics also be improved through the educational intervention?

An assertion was made stating that an educational intervention will improve learners' self-evaluation of their own effort and self-regulation in Mathematics. However, Analysis of Variance with effect sizes and powers results indicated that 2% of the between subjects variance was accounted for by enhanced volition self-efficacy in comparison to 0% variance of control group during Mathematics activities. Even LS means difference reduction from pre-test to post-test highlighted that treatment effect significantly favoured intensified volitional self-efficacy. Hence the enhanced treatment of volition self-efficacy was of significant small effect.

The results in 5.2.2.1 and 5.2.2.2 are in agreement about the effect of volitional self-efficacy which is self-belief in own ability. The confidence translates into reported learner exertion of own effort and self-regulation in Mathematics. The results are in agreement to Harris *et al.*, (2009:904) who consistently reveal strong positive correlations between learners' self-efficacy and subsequent academic performance, especially Mathematics performance. Even Malmivuori, (2006:161) specifies that high self-efficacy and positive affective responses are positively linked to pro-motive self-regulatory patterns of persistence and preference for challenge in Mathematics, see section 2.5.1.

The Analysis of Variance with effect sizes and powers' results of intervention effect for the self-control pressure scale revealed that the effect was almost statistically significant. The LS mean differences reduction after intervention with experiment group significantly favoured increased self-control pressure. Self-control pressure in par. 2.7.1 is referred to as the amount of effort learners deploy through use of volitional strategies towards goal maintenance. The difference between experiment and control group results with regard to increased emphasis on rehearsing intentions inhibits other cognitive or emotional subsystems in order to protect current intention. The results in 5.2.2.1 and 5.2.2.2 are in accord with Turner and Husman (2008:163) who highlight that learners' control-related and value-related appraisals are the excellent categories organizing their motivations and emotions. In par.2.3 the importance of regulating Mathematics learner actions to exert self-control over their cognition as they perform Mathematics tasks was mentioned. The findings are in harmony with those of Orbell (2003:97) that mechanisms of self-control lead to goal-maintenance which is the prime task of volition.

Failure control results of analysis of variance with effect sizes and powers indicated that the partial eta-squared of 2% for intervention group was accounted for by heightened failure control during treatment period. The variance for the control group was 1%, thus the enhanced treatment of failure control was of small effect, while the LS mean differences reduction after experiment group's intervention of increased awareness of how to deal with failure significantly favoured failure control. Failure control is a self-regulatory ability that entails the capacity to reduce negative affect when faced with difficulties (Cervone *et al*., 2006:341).

In addition the Analysis of Variance with effect sizes and powers results revealed the partial eta-squared of 0% despite intervention. Zero implied no variance accounted for between subjects by emotion control. But with LS mean differences method reduction after intensified emotion control experiment significantly favoured intensified emotion control. In section 2.7.2 reviewed literature by Wolters, (2003:190) points that emotional control describes learners' ability to regulate their emotional experience to ensure that they provide effort and complete academic tasks. Fredricks et al. (2004:74) include increases in positive affect and attitudes toward school among aspects of emotional engagement.

The gathered evidence in 5.2.2.1 and 5.2.2.2 is in favour of heightened effect of volitional self-efficacy, self-control pressure failure and emotion control. Hence the intervention improved learners' self-evaluation of their own effort and self-regulation in Mathematics.

5.2.2.2.1.2 Comparison between grade 9 experiment and control groups' self-evaluation of their own use of volition control and self-regulation in Mathematics in the pre- / post – and retention tests.

The L S means difference was also used as other way of making use of learner VCI reports to provide answers to research question three. The scales considered for pre-action and action volition control phases were respectively energy usage, planning and initiating ability, intention monitoring and attention control.

The results of mean values of lack of energy, planning and initiating ability scale scores prior to treatment and following non-treatment as compared with LS means t-test are shown in table 5.15.

Table 5.15. LS Means (crossover data) for lack of energy, planning and initiating ability scale

Cell no	Phase	Energy, Planning & initiatingMean	Energy, Planning & initiating	Energy, Planning & initiating	N
1	1	0.199	0.018	0.381	128
2	2	-0.139	-0.310	0.031	131

Cell no	Treatment	Energy, Planning & initiating Mean	Energy, Planning & initiating	Energy, Planning & initiating	N
1	Yes	0.122	-0.053	0.297	129
2	No	-0.062	-0.239	0.115	130

The LS mean differences reduction significantly favoured encouraged energy usage, planning and initiating ability.

The results of mean values of intention monitoring scale scores prior to treatment and following non-treatment as compared with LS means t-test are shown in table 5.16.

Table 5.16. LS Means (crossover data) for intention monitoring scale

Cell no	Phase	Intention monitoring	Intention monitoring	Intention monitoring	N
1	1	0.014	-0.209	0.237	123
2	2	-0.173	-0.381	0.035	127

Cell no	Treatment	Intention monitoring	Intention monitoring	Intention monitoring	N
1	Yes	0.054	-0.164	0.271	122
2	No	-0.213	-0.427	0.001	128

The LS mean differences increase did not significantly favour augmented intention monitoring.

The results of mean values of attention control scale scores prior to treatment and following non-treatment as compared with LS means t-test are shown in table 5.17.

Table 5.17 LS Means (crossover data) for attention control scale

Cell no	phase	Attention control res	Attention control res	Attention control res	N
1	1	0.175	-0.089	0.440	124
2	2	-0.197	-0.448	0.053	125

Cell no	Treatment	Attention control res	Attention control res	Attention control res	N
1	Yes	0.160	-0.094	0.413	126
2	No	-0.182	-0.444	0.080	123

The LS mean differences decrease significantly favoured augmented attention control.

5.2.2.2.12.1 Deduction about effects of learner use of energy, planning and initiation ability, intention monitoring and attention control in response to research question three.

Are there any significant differences in the perceptions of grade 9 learners from the study population with regard to self-evaluation of own volition control and self-regulation?

Some assertion is put forth suggesting that educational intervention will improve learners' self-evaluation of their own volition control and self-regulation in Mathematics. The evidence from the Analysis of Variance with effect sizes and powers revealed that 4% of the between subjects variance was accounted for by enhanced treatment of energy usage, ability to plan and to initiate Mathematics activities. The results of L S means difference highlighted that the reduction significantly favoured encouraged energy usage, planning and initiating ability. Therefore the evidence gathered in 5.3.2.1 and 5.3.2.3 is in favour of intervention effect. The results reaffirm that the learner perceptions with regard to the use of volitional strategy of energy usage, planning and initiating are of significant impact to Mathematics learning. According to the literature review in section 2.5.2, results are in agreement with, Dienfendorff and Lord, (2003:366) who reiterate that planning has volitional benefits that lead to increased learner persistence and confidence. Gollwitzer (1996:307) also contends that planning helps learners to mobilise effort in the face of difficulties and to ward off distractions.

The Analysis of Variance with effect sizes and powers results shows that 2.6% of the between subjects variance was accounted for by intention monitoring in comparison to 0% of the control group during Mathematics activities while L S mean difference suggests increase indicating that augmented intention monitoring did not have any significant effect. The evidence gathered here is not in favour of increased use of this particular volition strategy of intention monitoring. The intervention did not improve learners' self-evaluation of their own intention monitoring.

But the evidence gathered is slightly contrary to that derived in 5.2.2.1 with partial eta-squared that indicated some 1% difference accounted for by enhanced intention monitoring. Hence there is need to explore further the effect of intention monitoring using other statistical means.

The Analysis of Variance with effect sizes and powers results show that 3.8% of the between subjects variance is accounted for by enhanced learner attention control during Mathematics activities while for L S mean difference the decrease in mean significantly favoured augmented attention control.

In section 3.1, documented literature by Pape et al. (2003:182) allude to the facy that during the performance or volition control phase, self-regulated learners monitor and control their behaviours, cognitions, motivations and emotions by enlisting strategies such as attention control, encoding control, self-instruction and attributions. Therefore the evidence gathered in 5.2.2.1 and 5.2.2.2 is in favour of the strengthened attention control. The results confirm that intervention improved the learners' self-evaluation of their own volition control and self-regulation in Mathematics

5.2.2.3 A three-way and nested ANOVA

In order to enhance the results of crossover ANOVAs, a full factorial three-way *and nested* ANOVA was performed to evaluate the influence of treatment exposure, exposure duration and the interaction of the treatment exposure on both learner use of identified volitional strategies and math performance. Figures 5.9 to 5.16 indicate LS means to display a three way ANOVA for intention monitoring, attention control, self-control pressure, energy usage, planning and initiating ability, volitional self-efficacy, emotion and failure control and Mathematics tests.

5.2.2.3.1 Comparison of control group and experimental group intervention exposure, exposure duration and the interaction of the treatment exposure on both learner use of volition strategy use in pre - / post - and retention tests.

The analysis is carried to augment observed results to provide answers to the sub-question stating: Can learners' Mathematics- related volitional use be enhanced through an educational intervention in an innovative learner view on self-regulation? The pre-, post-, and retention test results were used to compare the experiment and control groups with regard to volition strategy use. A three-way *and nested* ANOVA yielded results as indicated in figure 5.9 to 5.16 for eight variables namely intention monitoring, attention control, self-control pressure, energy usage, planning and initiating ability, volitional self-efficacy, emotion and failure control and Mathematics tests.

Figure 5.9 represents the results of a full factorial three-way ANOVA performed to evaluate the influence of treatment exposure, exposure duration and the interaction of the treatment exposure on both learner use of intention monitoring and math performance.

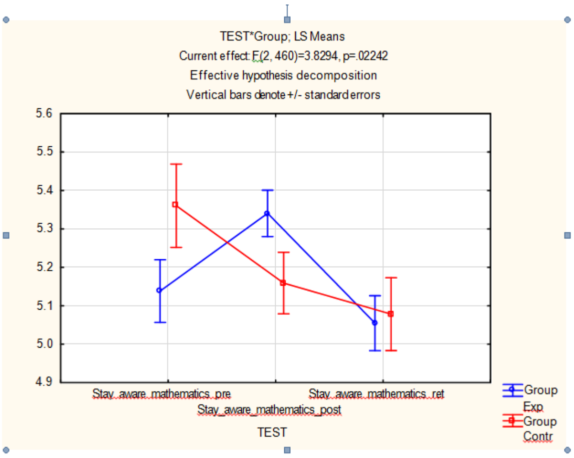


Figure 5.4 L S means for intention monitoring

Data on mean learner responses of intention monitoring of the experimental group and control group separated between pre-, post- and retention test indicate clear differences in learner responses. The experiment group reveals responses with intention monitoring effect of moderate increase from pre-test to post-test, but with sharp decline between post-test and retention test. The decline shows decreasing effect of intention monitoring with no intervention support. The control group responses reveal declining effect of intention monitoring almost similar to that experienced by experiment group with no treatment. With introduction of intention monitoring, some corrective measure is observed between post-test and retention as graph slope slightly increases.

The results support the findings of crossover ANOVA (see section 5.2.2.1) where for experiment group, intention monitoring value of $p = 0.09$ implied that the treatment effect was nearly statistically significant (at 1 degree of freedom and error of 116) and phase $p = 0.24$ was not significant.

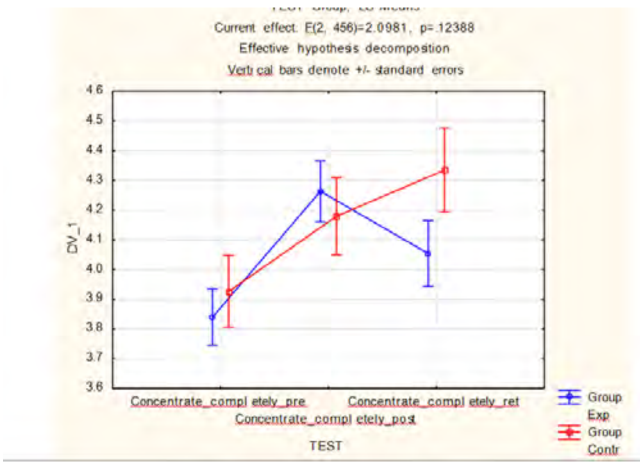


Figure 5.5 L S means for attention control

Data on mean learner responses of attention control of the experimental group and control group separated between pre-, post- and retention test indicate clear differences in learner responses. The experiment group reveals responses with attention control effect of sharp increase from pre-test to post-test but with moderate decline between post-test and retention test. The decline shows decreasing effect of attention control with no intervention support. The control group responses reveal moderate increasing effect of attention control with no treatment. With augmented attention control some moderate increasing effect is almost sustained between post-test and retention as graph slope continues to increase but is relatively flatter. The relatively flatter slope for the control group indicates that there was a significant reduction in attention control scores (indicating improvement in attention control) for this group after exposure to treatment.

The results support the findings of crossover ANOVA (see section 5.2.2.1) where for attention control value of $p = 0.07$ implied that the intervention effect was nearly statistically significant (p value almost equal to 0.05 at 1 degree of freedom and error of 114) and phase $p = 0.049$ was also significant.

The results of a full factorial three-way ANOVA performed to evaluate the influence of treatment exposure, exposure duration and the interaction of the treatment exposure on both learner use of self-control pressure and math performance are presented in figure 5.11.

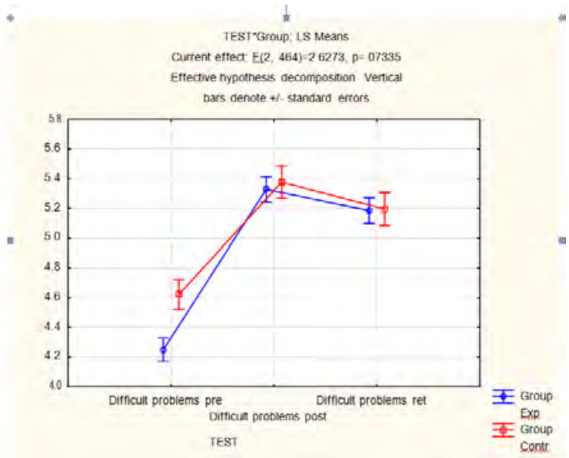


Figure 5.6 L S means for self-control pressure

Data on L S mean learner responses of self-control pressure of the experimental group and control group separated between pre-, post- and retention test indicate clear differences in learner responses.

The experiment group reveals responses with self-control pressure effect of very sharp increase and greater range from pre-test to post-test but with moderate decline between post-test and retention test. The experiment group decline shows decreasing effect of self-control pressure with no intervention support. The control group responses reveal sharp increase of self-control pressure effect within smaller range between pre-test and post-test. With introduction of self-control pressure support to control group some corrective measure is observed between post-test and retention as graph slope slightly decreases with effect almost similar to that of experiment group but without support. Therefore self-control pressure seems to have some slight effect on Mathematics performance.

The crossover ANOVA results for experiment group in 5.2.2.1 indicated existence of a very high statistical significance of period effect p = 0.00,1 but value of p = 0.39 for treatment effect denoted no statistical significance for self-control pressure field.

Figure 5.13 shows the results of a full factorial three-way ANOVA performed to evaluate the influence of treatment exposure, exposure duration and the interaction of the treatment exposure on both learner use of energy, initiating and planning ability and math performance.

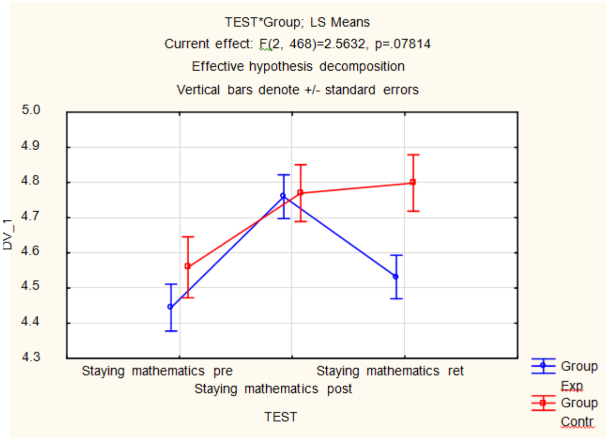


Figure 5.7 L S means for energy usage, initiating and planning ability.

Data on mean learner responses of energy usage, initiating and planning ability of the experimental group and control group separated between pre-, post- and retention test indicate clear differences in learner responses.

The experiment group reveals responses with energy usage, initiating and planning ability effect of sharp increase and greater range from pre-test to post-test but with also sharp decline between post-test and retention test. The experiment group sharp decline shows decreasing effect of energy usage, initiating and planning ability with no intervention support. The control group responses also reveal less sharp increase of energy usage, initiating and planning ability effect within smaller range between pre-test and post-test. With introduction of energy usage, initiating and planning ability support to control group some corrective measure is observed between post-test and retention as graph slope almost flattens. The relatively flatter slope for the control group indicates that there was a significant reduction in energy usage, initiating and planning ability scores (indicating improvement) for this group scores after exposure to treatment. Therefore energy usage, initiating and planning ability seem to have significant effect on Mathematics performance.

Even in 5.3.2.1 crossover ANOVA results indicate a very high statistical significance existence of period effect $p = 0.01$ for learner energy usage, planning and initiating ability, but for treatment effect value of $p = 0.153$ implies that the effect was not of any statistical significance ($p > 0.05$, at 1 degree of freedom and error of 115).

The results of a full factorial three-way ANOVA performed to evaluate the influence of treatment exposure, exposure duration and the interaction of the treatment exposure on both learner volitional self-efficacy and math performance are indicated in figure 5.13.

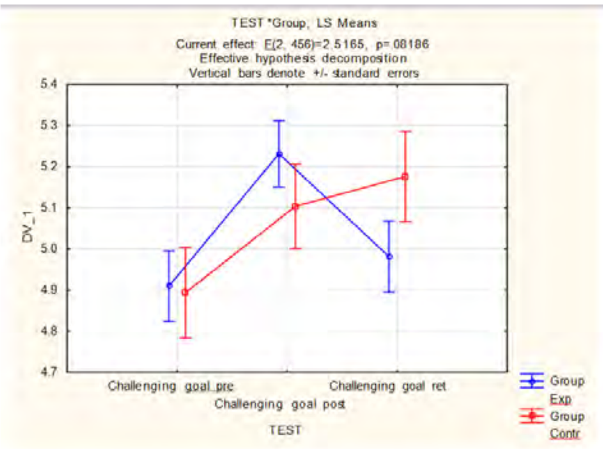


Figure 5.8 L S means for perceived volition self-efficacy.

Data on mean learner responses of volitional self-efficacy of the experimental group and control group separated between pre-, post- and retention test indicate clear differences in learner responses.

The experiment group reveals responses for volition self-efficacy effect of sharp increase and greater range from pre-test to post-test but with sharp decline between post-test and retention test. The experiment group sharp decline shows decreasing effect of volition self-efficacy with no intervention support. The control group responses also reveal moderate increase of volition self-efficacy effect within smaller range between pre-test and post-test. But with introduction of volition self-efficacy support to control group, some counteractive measure is observed between post-test and retention as graph slope slightly decreases. Therefore enhanced volition self-efficacy seems to have significant effect on Mathematics performance.

Also for the experiment group crossover ANOVA results for volition self-efficacy indicated a highly statistically significant period effect value of $p = 0.033$. However, the value of $p = 0.139$ for the treatment effect suggests no statistical significance.

Figure 5.14 shows the results of a full factorial three-way ANOVA performed to evaluate the influence of treatment exposure, exposure duration and the interaction of the treatment exposure on both learner emotion control and math performance.

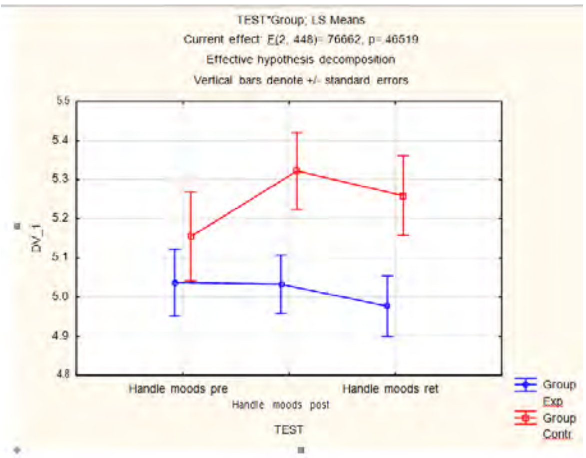


**Figure 5.9	L S means for perceived emotion control**

Data on mean learner responses towards emotion control of the experimental group and control group separated between pre-, post and retention test indicate clear differences in learner responses.

The experiment group reveals responses of almost no difference in effect for strengthened emotion control as the graph is nearly horizontal and has least range from pre-test to post-test, but slight decline between post-test and retention test. The experiment group decline suggests negative effect of emotion control with no intervention support. The control group responses also reveal moderate increase of emotion control effect within small range between pre-test and post-test. But with introduction of emotion control support to control group some negative decline is observed between post-test and retention as graph slope slightly decreases. Therefore augmented emotion control seems to have a small negative effect on Mathematics performance.

However, the results do not echo what crossover ANOVAs indicated: that p = 0.751 implied no statistical significance of intervention effect for learner emotion control and p = 0.451 indicated no statistical significance of the period.

The results of a full factorial three-way ANOVA performed to evaluate the influence of treatment exposure, exposure duration and the interaction of the treatment exposure towards learner failure control and math performance are given in figure 5.15.

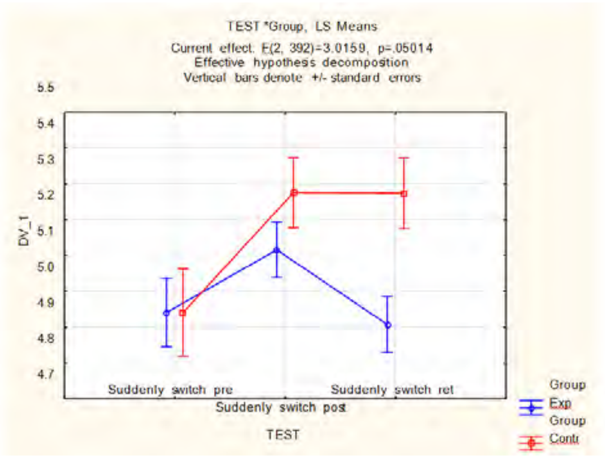


Figure 5.10 L S means for perceived failure control

Data on mean learner responses towards failure control of the experimental group and control group separated between pre-, post and retention test indicate clear differences in learner responses.

The experiment group reveals responses for failure control effect of moderate increase and small range from pre-test to post-test, but responses decline between post-test and retention test. The experiment group decline shows decreasing effect of failure control with no intervention support. The control group responses reveal greater increase in failure control effect with greater range between pre-test and post-test. But with introduction of failure control support to control group, some counteractive measure is observed between post-test and retention as graph slope almost levels. The relatively flatter slope for the control group indicates that there was a significant reduction in failure control scores (indicating improvement in failure control) for this group's scores after exposure to treatment. Therefore heightened failure control seems to have some effect on Mathematics performance.

The results are in agreement with crossover ANOVA results of the experiment group about statistically significant period effect $p = 0.049$. However, $p = 0.987$ for intervention effect for learner failure control implied no statistical significance.

5.2.2.3.1.1 Deduction about effects of intervention exposure, exposure duration and the interaction of the treatment exposure on learner use of volitional strategies

Can learners' self-evaluation of their own volition control and self-regulation in Mathematics be improved through the educational intervention?

The results of a three-way *and nested* ANOVA enhanced observation from the crossover ANOVA in revealing a significant main effect of intensified treatment on learner use of intention monitoring, attention control, self-control pressure, use of energy, initiating and planning ability, volition self-efficacy and failure control. It is only for emotion control that the results reveal a small negative effect after intensified treatment.

5.2.2.4 Mathematics Tests

5.2.2.4.1 Comparison between grade 9 learner intervention of volition strategies' use and Mathematics test performance

The LS means crossover was performed to evaluate significance in differences between learner Mathematics test performance of experiment and control groups. In Appendix B, figure 5.10 for experiment group Mathematics test results of the period effect with value of $p = 0.034$ and $F(1, 153) = 4.59$ ($p < 0.05$, at 1 degree of freedom and error of 153), indicate statistical significance. Also, the value of $p = 0.000$ for the experiment group treatment effect and $F(1, 153) = 333.04$ ($p < 0.05$, at 1 degree of freedom and error of 153) suggests high statistical significance of the Mathematics test.

The results of mean values of Mathematics tests scores prior to treatment and following non-treatment as compared with LS means t-test are shown in table 5.18.

Table 5.18 L S means crossover Mathematics tests data

Cell no	treatment	Test res Mean	Test_res Std.Err.	Test_res	Test_res	N
1	Yes	13.30	1.184	12.11	14.48	154
2	No	-17.63	1.184	-18.81	-16.45	154

Cell no	phase	test_res Mean	Test_res Std.Err.	Test_res -Std.Err.	Test_res +Std.Err.	N
1	1	-3.97	1.184	-5.15	-2.78	154
2	2	-0.37	1.184	-1.55	0.82	154

The crossover LS mean differences at week 8 post-test date between enhanced volition intervention score for experiment group reduced from 13.30 baseline in period 1, Current effect: $F(1, 153)=339.04$, $p=0.000$ to -3.97 in period 2. The decrease significantly favoured Mathematics test scores after enhanced treatment of self-control pressure, intention monitoring, and energy usage, planning and initiating ability, attention control, volition self-efficacy, emotion and failure control.

The significant LS mean difference between experimental and control groups suggests that the structure or process represented by the volitional item is instrumental in Mathematics test performance. The effectiveness of volition intervention in improving both the functional level and Mathematics performance as evidenced by high and low achievers will be endorsed by crossing over to a qualitative method of data analysis.

5.3 QUALITATIVE ANALYSIS OF GRADE 9 MATHEMATICS LEARNERS' USE OF VOLITION AND INTERPRETATION

The researcher gathered information inductively through interviews to establish knowledge about how learners make use of selected volitional strategies. The open-ended learner interviews were conducted with high and low performing learners. The interviews also determined experiential reasons behind learner completion or non-completion of Mathematics homeworks. The analysis and interpretation of interviews provided the researcher with a more comprehensive and complete understanding of the phenomenon of volition that propels character of the interactions among learners in the classroom setting. All the findings were measured against the findings from literature review conducted in Chapter 2 and Chapter 3.

Interview reflections: high achieving learners

Interview reflections with regard to learner responses concerning their use of seven volition strategies.

Reflection with regard to Learner 1's responses regarding:

Self-control pressure:

- *tries hard to work toward Mathematics goals set*
- *forces self to take out of mind that which bothers her, and*
- *willing to take decision to sit down and do Mathematics work*

Intention monitoring

- *Uses self-talk to remind self of own intentions*
- *tells self that she has to do Mathematics work*

Energy usage

- *builds up energy to work hard toward achieving Mathematics goals set*
- *first struggles to get meaning of words from dictionary*

Planning

- *sticks to own schedule of doing homework*
- *figures out the steps needed to reach the answer*

Volitional self-efficacy

- *hopeful that if she tries hard enough she will succeed*
- *if she improves on some attempted hard work then Mathematics is no longer difficult for her*

Attention control

- *recollects self to pay attention*
- *uses self-tell to direct concentration to Mathematics work*
- *reminds self to ignore any disturbance*
- *looks at the keywords and tries to follow the steps*

Emotion control

- *even though she gets irritated and becomes moody, she recollect self to pay attention*
- *forces self to take out of her mind that which bothers her*

Failure control

- *follows the new method but finds out why method she used was wrong*
- *adjusts to change and ignores any criticism*

In addition the learner indicated making self-reflections by

- *reflecting on marks obtained and the way the Mathematics teacher was showing them the skills*
- *reflecting to check whether she is pleased or not with effort put on her Mathematics*
- *if not pleased with marks obtained, she commits self to spend more time working on maths problems.*

Reflection with regard to Learner 2's responses regarding:

Self-control pressure.

- *Tells self to put more effort into working on Mathematics*
- *Tells self to pay more attention to Mathematics because it is important in her future plans.*
- *Tells self to work hard in Mathematics and puts pressure when she feels like giving up*

Intention monitoring

- *Tells self to put in more effort because Mathematics is the subject that will make her pass*

Energy usage

- *loses strength and courage when she does not understand then tries draw strength by asking questions and self-encouragement*
- *tells self to change habits to improve Mathematics understanding*

Planning

- *has a time-table which she follows*
- *figures out the steps needed to get to answer before actually writing down*

Volitional self-efficacy

- *believes in self ability to do work out correct steps*
- *puts trust and hope in self that she is able to perform better*
- *is always hopeful that by trying hard she will succeed*

Attention control

- *ignores any distraction, starts by looking at the key word, checks the formula and starts to write*
- *looks at the keywords, tries to follow the steps*
- *tells self to concentrate on work in order to do it correctly.*

Emotion control

- *when involved in a difficult project it pains her, but she refrains from imagining things that are corrupt and calms self to better the situation*
- *refrains from becoming angry with Mathematics teacher*

Failure control

- *takes time to change own method but does try to do as advised by the teacher*
- *if occupied with one thing for a long time and advised to change, she tells self to do it the teacher's way.*

Reflection with regard to Learner 3's responses regarding:

Self-control

- *exerts pressure on self and puts a lot of effort into Mathematics activities.*
- *forces self to do that formula over and over again*
- *tells self to do the work because it is for one's own good to pass Mathematics*

Intention monitoring

- *sets time to do and finish Mathematics work*
- *sets an alarm to remind her of the work she has to do*
- *tells self to avoid getting lower marks in Mathematics.*

Energy usage

- *draws energy from telling self to work hard*

Planning

- *plans before doing Mathematics activity.*

Volitional self-efficacy

- *level of confidence is very high about doing well in Mathematics.*
- *self-belief in having potential to understand Mathematics.*

Attention control

- *ignores other things that don't involve Mathematics because*
- *focuses on the question's keywords to help solve the problem*
- *always chooses to pay attention to the formula and writes it in the book several times*

Failure control

- *accepts the correction quickly because she thinks it is better to be corrected when wrong so as to avoid being stuck in one place*
- *being corrected upsets her but she ends up following the new formula*

Reflection with regard to Learner 4's responses regarding:

Self-control pressure

- *expresses willingness to put effort on Mathematics work and puts pressure on self to do it.*
- *does homework under pressure when time is running out*

Intention monitoring

- *Consistently reminds self of own set goal to understand and achieve high marks.*

Energy usage

- *does not have doubts because he knows that success in Mathematics is for the best*
- *draws energy to try again and does not neglect difficult tasks*
- *believes he has the power to achieve high marks*

Planning

- *uses some sort of a timetable to manage time*
- *figures out the steps needed to work towards the answer before writing down*

Volitional self-efficacy

- *believes that he can do it in Mathematics regardless of whether problems are hard or not*
- *has high self-confidence and is always sure that what he writes in Mathematics steps are correct*

Attention control

- *focuses on formulas and keywords and in a test focuses on what he has been practising and writing.*
- *looks out for the keywords, concentrates on the formulas and questions*

Emotion control

- *deals with own moods by applying the strategies that help him persevere, on the fact that if he does not perform well he will fail and that is not for his own good.*

Failure control

- *in instances of being wrong he quickly adjust to the new method*
- *easily changes the old routine and adjusts to the new routine*

In addition the learner

Spends time on doing the homework and always does it the next available time

Reflection with regard to Learner 5's responses regarding:

Self-control

- willing to put more effort into Mathematics work to reach set goal
- forces self to stay behind in the classroom and put more concentration into what teacher explained
- pushes self at home or at school to practise Mathematics
- to boost self-control to keep doing Mathematics, and as relaxation technique, learner takes a deep breath, then starts concentrating on Mathematics work at hand

Intention monitoring

- *forces self to stay focused on Mathematics activity no matter what.*
- *always reminds self about homework to do*
- *encourages self of importance to do Mathematics*
- *sets an alarm to remind him when it is time set to do Mathematics*

Planning

- *makes use of timetable to remind when it is time for Mathematics.*
- *asks self how many steps are needed to go through to get to the answer.*

Volitional self-efficacy

- *believes in self to continue successfully with assigned work.*
- *thinks positively when pursuing a challenging goal*
- *self-confidence level is high because of self-belief*

Emotion control

- *turns self to be positive when encountering challenging Mathematics tasks*
- *may get angry at being corrected but will re-adjust Mathematics approach to new way*
- *knows how to take control over own moods*

Failure control

- *when corrected expresses that he may continue the wrong way for a while but later agrees to change*

In addition the learner expresses

- *the need to give self-time to practise Mathematics*

Reflection with regard to Learner 6's responses regarding:

Self-control

- *willingly tries to focus hard on Mathematics work at hand*

Intention monitoring

- *tells self to stick with Mathematics activity*
- *reminds self by checking classwork exercise book*
- *tells self to stick with homework*
- *reminds self of intention to get better mark, then continues with Mathematics work*

Planning

- *makes use of timetable*
- *asks self how many steps are needed to get to the answer*

Volitional self-efficacy

- *believes can do it even if it is hard and forces self to work on Mathematics*
- *learner puts trust in self and believes in personal ability to succeed.*
- *level of confidence is high when fixing own mistakes*

Attention control

- *learner focuses on Mathematics and asks question when he does not understand.*
- *tells self to stay focused on the formula and keyword*
- *asks for meaning of important word like "possible" in probability*
- *focuses on steps, keywords and also formulae which are important in solving Mathematics problems*

Emotion control

- *tells self to deal with moods correctly whilst working on Mathematics problems*

Failure control

- *when corrected, expresses feeling of sadness but tells self not to show any anger, and does what the teacher recommends*
- *it seems difficult when he has to switch methods, but forces self to change*

In addition learner expresses the need to take time to do Mathematics activities and making correct use of time.

Interview reflections: low achieving learners

Interview reflections with regard to learner responses concerning their use of seven volition strategies.

Reflection with regard to Learner 7's responses regarding:

Self-control

- *feels sad because of not setting clear goals but does nothing about it*
- *Intention monitoring*
- *depressed about not having goals; however, enjoys playing with friends and leaves working on Mathematics homework*
- *completely neglects working on any Mathematics work*

Planning

- *lack of planning and as a result no work to do*
- *lack of time to do Mathematics but hopes one day will be able to work on it.*

Volitional self-efficacy

- *believes Mathematics is very difficult*
- *has no self- confidence about doing Mathematics and as a result does not make any attempt on assigned work*

Attention control

- *experiences difficulty to fully concentrate on Mathematics, feels very nervous and ultimately leaves working on it*
- *sometimes may want to work on Mathematics but unable to sustain the decision and leaves it*
- *experiences lot of doubt that makes him leave working on Mathematics.*
- *Emotion control*
- *feels sad and does not know how to deal with this state that makes him to do nothing*

Reflection with regard to Learner 8's responses regarding:

Self-control

- *even before starting, feels like he can't do it or solve the problem*

Energy usage

- *when faced with challenging Mathematics problem, feels tired and exhausted*
- *sometimes even lazy to write down into exercise book the correction on the board*

Planning

- *no planning; as a result easily abandons working on Mathematics*
- *Volitional self-efficacy*
- *when faced with a challenging goal the words "I can't" crosses his mind, so he gives up on doing Mathematics.*

Attention control

- *instead of paying attention or concentrating, starts to play and takes advice of other learners not to do the work.*

Emotion control

- *when faced with challenging Mathematics problems, in a bad mood that he cannot control.*

Reflection with regard to Learner 9's responses regarding:

Self-control

- *thinks that he can't do Mathematics. Has self-doubts, is not able to write what the teacher is telling them in correct words.*

Volitional self-efficacy

- *has no self-confidence, lacks knowledge in Mathematics. Self-doubt to do Mathematics makes learner to be easily distracted: has difficulty paying attention.*

Emotion control

- *when dealing with challenging Mathematics tasks, learner reports becoming moody and avoids doing problems because of lack of knowledge.*

Reflection with regard to Learner 10's responses regarding:

Volitional self-efficacy and emotion control

- *has low level of confidence in Mathematics; believes that Mathematics is too difficult. Subsequently when dealing with challenging Mathematics tasks, learner reports being too nervous and not able to concentrate; lacks paying attention. Because learner does not know how to handle own emotions, he reports turning to other things.*

Reflection with regard to Learner 11's responses regarding:

Self-control:

- for Mathematics related activities, learner has no clear goals and prefers to let things run their course.

Volitional self-efficacy:

- level of confidence is low which is a problem when solving difficult Mathematics questions. Learner is usually clouded with negative thoughts; experiences disheartened moods in relation to Mathematics. As well finds it hard to respond to correction; rather continues with what he had been doing.

Reflection with regard to Learner 12's responses regarding:

Self-control

- *learner does not set any goals; as a result ends up leaving her Mathematics work. Unable to take control of time for doing Mathematics; does not plan and ends up doing no Mathematics related work on her own*

Volitional self-efficacy

- *has a low level of confidence when solving difficult Mathematics problem; thoughts sometimes negative. Discouraged when involved in difficult project; does not know how to handle moods because she does not know Mathematics. Difficult to adjust to new situations and demands: as a result she feels more defeated by failure.*

In summary, the interview results reveal that the low performing Mathematics learners report the following inappropriate practices. Learners deal with the goals incorrectly, they give up easily on Mathematics tasks and do not put pressure on themselves towards goal attainment. Low performing learners make inadequate decisions not to stay aware of their intentions. Learners do not know how to take control of time for doing Mathematics as there is no report of evidence of planning like in use of timetable. They are not able to concentrate completely on Mathematics as they report being nervous. In addition low performing learners report not knowing how to react to correction of the wrong method. They find it hard to control failure and to adjust to new situations. The learner level of confidence as reported, is low. Learners doubt their own ability and have no volitional self-efficacy. Moreover, low performing learners do not know how to deal with their moods; challenging Mathematics tasks cause them to be sad, they are doubtful, negative and also report avoiding tackling the tasks.

On the other hand, learners who perform well in Mathematics report making use of some volitional strategies during Mathematics activities. High performing learners report subjective improvement in their intention monitoring, in memory retention and persistence in reminding self. Some high performing learners report making use of intention monitoring to become aware of goal progress. When encountering challenging tasks learners draw energy from being hopeful, self-belief thus making use of own volitional self-efficacy. The interviewed achieving learners report being able to take control of time on Mathematics related activities by making use of timetables and setting an alarm for reminder. Furthermore, learners ensure that their attempt will be correct by figuring out the steps as in planning. In addition some high performing learners report using volitional and relaxation techniques like taking a deep breath, singing and praying to increase concentration. Other high performing learners report making use of self-control pressure as in self-talk that is telling self to stick with own work, to ignore any disturbance. The learners also report being able to control emotions and react well in response to failure by adjusting to the new routine or method.

5.4 MERGING OF QUANTITATIVE AND QUALITATIVE DATA ANALYSIS

The third phase also entailed application of mixed methods by crossing over of quantitative means of data collection to qualitative means through interviewing of some sampled learners in the experiment group. The rationale of mixing quantitative and qualitative methods assists in assessing the reliability of the intervention, and this contributes towards treatment integrity (Leech & Onwuegbuzie, 2010:63). The results of assessment provided outcome data related to the impact of the intervention and allowed for an on-going formative evaluation of the intervention process.

5.4.1 Results: Relationship in learner volitional strategy use and Mathematics tests performance

A three-way and nested ANOVA was performed to evaluate the influence of treatment exposure, exposure duration and the interaction of the treatment exposure on both learner use of volitional strategies and math performance. Figure 5.11 indicates results of L S means for Mathematics test scores.

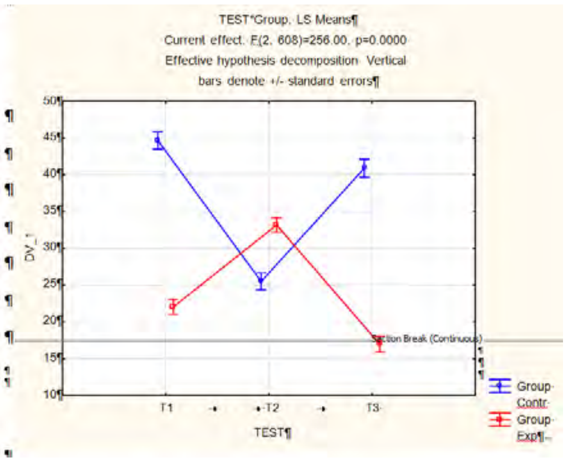


Figure 5.11 L S means for Mathematics test scores

Data on L S mean Mathematics test scores for the experimental group and control group separated between pre-, post- and retention test indicate clear differences in learner performance. The experiment group revealed performance test scores with moderate increase from pre-test to post-test but with sharp decline between post-test and retention test. The decline showed decrease in performance with no intervention support. The control group responses revealed declining performance almost similar to that experienced by the experiment group with no treatment. With introduction of enhanced volition treatment, some corrective measure is observed between post-test and retention as graph slope sharply increases.

The results of a three-way nested ANOVA are in agreement with crossover ANOVA with value of $p = 0.000$ for the experiment group treatment effect that suggests high statistical significance of Mathematics test. In addition, experiment group Mathematics test results of the period effect with value of $p = 0.034$ indicate statistical significance.

5.4.1.1 Grade 9 effect of intervention on volition strategy use and Mathematics performance in response to hypothesis four.

Do learners' volition uses predict their achievement in Mathematics?

The study design implemented in this trial provides an opportunity to determine with precision the magnitude of the treatment effects compared with the period, and sequence effects found in crossover study designs.

The results of a three-way nested ANOVA are in agreement with crossover ANOVA that intervention entailing the enhancement of some selected volition strategies as treatment did have statistical significant effect on Mathematics tests.

The quantitative analysis was integrated with subjective qualitative response analysis in order to make deduce sound information about specific questions emanating from research question four.

5.4.1.1.1 How do Mathematics learners with more sense of planning and initiating achieve in comparison to learners with less sense of planning and initiating?

In regard to planning, interviewed high achieving learners reported taking control of time by making use of timetables and setting an alarm for a reminder. Furthermore, learners ensured that their attempt will be correct by figuring out the steps required while planning. On the other hand, low performing learners reported not knowing how to take control of time for doing Mathematics as there was no report of evidence of planning like use of timetables or planned steps.

5.4.1.1.2 How do Mathematics learners who often monitor their intentions perform in comparison to learners who seldom monitor their intentions?

Some high performing learners report making use of intention monitoring to become aware of their goal progress, forcing them to stay focused on Mathematics activity no matter what, knowing how to remind themselves about homework to do, encouraging themselves by remembering how important it is to do Mathematics. But interviewed low performing learners made inadequate decisions not to stay aware of their intentions.

5.4.1.1.3 How do Mathematics learners who are less distracted in attention perform in comparison to learners who are easily distracted?

The interviewed low performing learners reported being easily distracted, a lack of ability to concentrate completely on Mathematics as they are nervous and therefore do not pay attention. This aspect was not reported by high performing learners; rather they report knowing how to ignore any distraction, what to focus on like formulas and keywords, or focusing on what they are practising and writing, how to refresh their minds, and self-talk to promote concentration on work in order to be correct.

5.4.1.1.4 How do Mathematics learners who exert more self-control pressure achieve in comparison to learners with less self-control?

Some high performing learners reported making use of self-control pressure as in self-talk which is telling oneself to stick with work at hand, to ignore any disturbance, to be willing to put effort on Mathematics work and to put pressure on oneself to do it even when they feel like giving up. But the low performing learners reported incorrect dealing with the Mathematics goal, they gave up easily on Mathematics tasks and did not put pressure on themselves towards goal attainment.

5.4.1.1.5 How do Mathematics learners with more tendencies to control failure and emotions achieve in comparison to learners with no tendency to control failure and emotions?

The high achieving learners also reported being able to control emotions and react well in response to failure by adjusting to the new routine or method. But the low performing learners reported not knowing how to react to correction of the wrong method. They found it hard to control failure and to adjust to new situations. Moreover, low performing learners did not know how to handle their moods, challenging Mathematics tasks cause them to be sad and clouded with negative thoughts. They experience disheartened moods in relation to Mathematics, are doubtful and avoid tackling the tasks.

5.4.1.1.6 How do Mathematics learners with high volitional self-efficacy perform in comparison to learners with low volitional self-efficacy?

When high achieving learners encounter challenging Mathematics tasks, they report drawing energy from being hopeful and from self-belief; thus making use of volitional self-efficacy and being able to spend more time on Mathematics. On the other hand, low performing learner level of confidence is reported to be low. Learners doubt their own ability, have low volitional self-efficacy beliefs. They do not pursue tasks for a long duration of time, but rather avoid working on Mathematics tasks.

5.4.1.2 Research question 4: Do learners' volition uses predict their achievement in Mathematics?

The crossing over of methods used for comparison and further analysis with interview themes determined some links between volition strategy use and Mathematics achievement. The use of both quantitative data and qualitative data analysis techniques enhanced the interpretation of significant findings (Leech & Onwuegbuzie, 2010:63). The results for the pre-, post- and retention test data analysis indicated that the six volitional strategies contributed differently to Mathematics performance. Specifically, planning (par. 2.4.3 and par 2.5), volition self-efficacy (par. 2.5.1), intention monitoring (par. 2.6.1) and self-control pressure (par. 2.7.1) seemed to contribute to high performance. High performing learners reported making use of self-control pressure as in self-talk and being able to control emotions and reacting well in response to failure by adjusting to the new routine (see par. 5.4.1.1.4).

There is evidence from the literature that volitional strategy use nested in Mathematics performance reveals a significant main effect of intensified treatment on learner use of strategies. These findings are consistent with research by Wolters and Rosenthal, (2000:817) documenting that learner use of intention monitoring serves as one mechanism through which attitudes translate into greater effort and persistence at Mathematics tasks. In section 2.6.1, literature by Cobb *et al*., (2001:121) attributes mental activity and intelligence to intention monitoring, control of thinking and control of emotions demonstrated by individual learners' reasoning ability. Perry *et al*. (2005:559) suggest strong negative emotions associated with failure, such as anxiety or fear, and excessive cognitive distraction resulting from failure, are known to impair learning and reduce Mathematics achievement. Poor executive functioning is associated with cognitive deficits, poor socio-emotional adjustment, and poor academic functioning (Blair, 2002:113), which may manifest as a lack of concentration, a lack of understanding of cause and effect, an inability to understand mental states, and/or impulsivity (Riggs, Jahromi, Razza, Dillworth-Bart, & Mueller, 2006:301)

The lack of emotion and failure control seems to contribute to low Mathematics performance as learners lack ability to concentrate completely on Mathematics as learners reported being nervous, negative and doubtful and avoid tackling challenging tasks (see par. 5.4.1.1.4).

It can be deduced that, from the sample group, learners who made use of volitional strategies achieved at a higher level than learners who did not fully make use of their strategies in grade 9.

5.5 SUMMARY

Learner participation in a volition enhancement programme was associated with improvements in self-regulation, control of cognition as in ability to concentrate completely, and specific domains of planning, intention monitoring, volitional self-efficacy, self-control pressure, emotions and failure control based on learners' reports. Analysis of individual subscales showed that learners reported improvement in own abilities to shift, initiate, and monitor. These are central skills practiced by engaging in volition enhancement program, that is, control over Mathematics performance and learning processes, perceptions of persistent pursuit on Mathematics performance and learning process, bringing attention to self-regulation processes of forethought, volition control and self-reflection.

Nevertheless, our study has demonstrated the effectiveness of volition training in improving both the functional level (self-regulation) and Mathematics performance while confirming that an integration of volition in learning could add value to Mathematics reaching and learning.

The findings from the quantitative & qualitative data analysis and interpretations and literature review will provide the researcher with a construct for a volition enhancement self-regulation programme. In the next chapter a construct of volition enhancement self-regulation programme will be proposed as a means to improve learners' Mathematics performance in grade 9 Mathematics classes in rural community schools.

CHAPTER 6

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This final chapter presents a summary of the research study. The chapter includes the core of the previous chapters, describes the findings according to the research aims and concludes by making some recommendations.

The final chapter, therefore, presents an outline of the investigation conducted. In this chapter a brief summary of the research is given in order to establish that the aims of the research study as stated in 1.3.1 have been accomplished. The overall summary is made from both the theoretical and empirical perspective. The summary will focus on findings arising from the literature review, from both quantitative and qualitative research method sections. This is followed by conclusions and recommendations that are drawn from the findings of this study.

The main research recommendations include the proposed volition enhancement self-regulation model stemming from analysis, discussions and findings made. Finally, the limitations of this study followed by areas for further research are identified to conclude Chapter 6.

6.2 OUTLINE OF THE INVESTIGATION

This section gives a summary of the study. The general overview of the contents of each chapter is given, followed by major themes that emerge from the literature review and empirical findings in order to suggest a way to address the questions.

6.2.1 Summary of the research study

In Chapter 1 the background of the research project was set out. This includes the purpose of the study, problem statement, the research question and secondary questions, the objectives of the study and, clarification of the concepts, the research methodology, and the research framework. The research project intends to develop, implement and evaluate a model to enhance learners' volitional strategies use in order to augment Mathematics teaching and learning achievement in grade 9, particularly in a rural community school.

The quality of South African Mathematics achievement in some rural community schools raises concern which motivates the need to address some maladaptive learning practices entrenched within the school context. The malpractices in consideration are believed to affect Mathematics learner engagement patterns. Learner engagement during Mathematics learning activities is characterized as a component construct containing behavioural, emotional and cognitive aspects. Even though these components of engagement contribute significantly to changes in learning patterns, some Mathematics learners still are not well resourced. Learners do not know how to self-regulate their thoughts in order to achieve Mathematics goals. For example lack of volition use has some disruptive effect on processes of cognition and emotional functioning. On the contrary, research evidence suggests that enthusiastic volitional strategy use impacts on the use of cognitive learning strategies, mathematical thinking and ultimate individual achievement in Mathematics.

Mathematics learners experience behavioural patterns that entail inability to make timely decisions, commit to a course of action or initiate Mathematics activity without being compelled to. Some Mathematics learners do not spend sufficient time on their homework, they procrastinate or attempt working on homework at the last minute. Some learners are ill equipped with regard to handling multiple competing tasks, maintaining challenging goals or persisting despite first attempt failures or setbacks. Corno (1993:16) posits volition as a system of psychological control processes that protect concentration and direct effort in the face of personal and / or environmental distractions and so aid learning and mathematical achievement.

There is not much research that addresses secondary school learners' understanding and use of volitional strategies. Hence there is a need to better explore how learners make use of volitional strategies to facilitate improved access to Mathematics process skills.

Subsequently the purpose of this research was to develop, implement and evaluate a model to enhance learners' use of volitional strategies use so as to augment Mathematics teaching and learner achievement in grade 9, particularly in a rural community school.

The research aim included:

a) Developing the Mathematics teaching and learning model that will support learner use of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy.

b) Identifying Mathematics strengths and weaknesses learners develop when their sense of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy use are increased.

c) Examining the effects of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy on grade 9 Mathematics learner achievement.

d) Determining how application of the developed model influenced teaching and learner achievement in grade 9 Mathematics classrooms (see section 1).

The aim of the study was broadly grounded on the investigation of the four main research questions asked.

Research question 1

Can learners' Mathematics- related volitional use be enhanced through an educational intervention in an innovative learner view on self-regulation?

Research question 2

Can learners' self-evaluation of their own effort and understanding in Mathematics also be improved through the educational intervention?

Research question 3

Can learners' self-evaluation of their own volition control and self-regulation in Mathematics be improved through the educational intervention?

Research question 4

Do learners' volition strategies' uses predict their achievement in Mathematics?

The researcher contended that Mathematics learners who make use of volitional strategies achieve at a higher level than learners who do not fully make use of their strategies in grade 9. The fourth question was further broken up into specific questions:

- How do Mathematics learners with more sense of planning and initiating achieve in comparison to learners with less sense of planning and initiating?
- How do Mathematics learners who often monitor their intentions perform in comparison to learners who seldom monitor their intentions?
- How do Mathematics learners who are less distracted in attention perform in comparison to learners who are easily distracted?
- How do Mathematics learners who exert more self-control pressure achieve in comparison to learners with less self-control?
- How do Mathematics learners with more tendencies to control failure and emotions achieve in comparison to learners with no tendency to control failure and emotions?
- How do Mathematics learners with high volitional self-efficacy perform in comparison to learners with low volitional self-efficacy?

The specific objectives of the research project are to:

a) Analyse learner perceptions about volitional strategies learners use during Mathematics learning.

b) Determine the relative influence of volitional strategies learners use on effort maintenance and self-regulation during Mathematics learning of grade 9 learners.

c) Evaluate learners' perceptions of their volitional strategy use with reference to volition control and self-regulation during Mathematics learning of grade 9.

d) Determine the relative influence of volitional strategies learners use on the learning and achievement in Mathematics of grade 9 learners.

e) Evaluate learners' perceptions of their volitional strategy use with reference to their performance in Mathematics of grade 9.

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

In Chapter 2 the focus is on understanding the upheld learning view that encompasses the constructivist approach and activity theory. A literature review provides theoretical perspectives on the concept of volition and its role in relation to Mathematics learning, as well as perspectives on self-regulation, the critical feature of the proposed volition model. Hence discussion is centred on the role of the three cyclic phases of pre-action, action and volition control phase and post-action phase, needed in self-regulation. The importance for management and effort control volition phase needed for Mathematics goal intention maintenance is emphasised.

Chapter 3 focuses on some of identified Mathematics teaching and learning strategies that contribute to self-regulation and form the building blocks of the model. Special attention is given to the education system in terms of inputs (including contexts), processes and outputs. An inclusive view is presented of teachers' characteristics in regard to their constructive contribution towards to learners' classroom motivational and volitional aspects of learner conduct. As well effects of different processes in class in determining learner engagement patterns is considered in view to improve the volition enhancement model. The processes involved in class include teaching style, behavioural patterns, emotional responses, cognitive aspects and time spent on Mathematics learning activities. Chapter 3 also highlights the need of instruction that foster volitional functioning. A discussion is given on the interconnectedness of learner use of volitional strategies with a view to promote learner self-reflection that generates feedback. Aspects of the model include information on feedback needed for confirming or re-examining and modifying strategies in order to select and use more productive procedures.

Chapter 4 provides the research design and a methodological perspective on achieving the objectives set out for this study. This chapter looked into the methodology used in gathering data for this study. The chapter focused on a description of the systematic and focused approach according to the following topics: purpose of empirical section, research questions, design-based research, mixed method research approach, quantitative research and qualitative research, ethical aspects and administrative procedures.

Chapter 5 presents the results, the data obtained are processed, recorded and analysed. The volition intervention programme implemented at schools is outlined. Furthermore data are interpreted and the statistical techniques used in the research are described.

Chapter 6 presents a summary of the research, findings, recommendations for further research and limitations encountered during this study.

6.3 FINDINGS

6.3.1 Summary of findings emanating from the literature review

From the literature review certain elements that guide the construction of volition enhancement self-regulation model are established and provide research with a learning background to improve learner performance in grade 9 Mathematics classrooms in rural community schools situated in Bojanala District.

The first theoretically established element is making use of activity theory and constructivist model to achieve high grades during Mathematics learning.

The literature review makes special reference to learning theories. In 2.1.1 activity theory provides framework for the research conducted. The facts that form the core of the volition model entail goal setting during self-regulation and emotion control. In line the subjects of activity, a group or individual member of activists, consciously set goals, while the actions that constitute an activity are energised by its motive and are directed toward conscious goals. Hence the nature of social interaction in class must be conducive to encourage learner participation. This is in view of the fact that, amongst other factors, learners also have to deal with their own emotions to respond, actively listen, work on assigned tasks and contribute towards group discussions willingly. Activity theory is brought forth to explain how a teaching approach that emphasizes understanding and meaningful ways may contribute towards Mathematics learning. The importance of the structure of social interaction as source of the structure of human thinking as emphasized by Even and Schwarz (2003:297) is considered in the light of promoting self-regulation. Therefore the significant role of the teacher aimed at helping the learners become involved, understand and develop a sense of shared ownership of the Mathematics activity’s motive as well as the actions’ goals, is highlighted.

In 2.1.2, according to constructivist view, Mathematics learning is an intentional process that entails developing meaning through learners’ own constructions. The prime focus of constructivist learning/teaching is engaging learners in productive thinking, analysing, and synthesising of ideas through individual and social construction of knowledge. Hence the research argues for an active role for Mathematics learners who incorporate use of volitional strategies towards knowledge construction.

In 2.2.3 according to research findings learners in rural schools perform worse than their counterparts in the urban areas. Some of the challenges that teaching in rural communities pose involve motivating learners to learn intentionally, autonomously and effectively. In addition learners from rural areas tend to experience high levels of early school leaving than their counterparts in urban areas. Subsequently learners from rural communities face what has been referred to as 'silent exclusion' or lack of epistemic access. Therefore it is important to have more understanding and to develop means for sustainable empowering learning environments and scholarship of engagement with a clear focus on quality learning for democratic citizenship in a socially just context.

The second theoretically established element is self-regulation

Learning is a process that is defined by sequences of state measurement over time. The cyclic sequences in self-regulation form the key concept of the volition model. In 2.4.2 learners' self-regulation for goal-striving incorporates goal-setting and goal-commitment with self-monitoring, self-evaluation and self-reactions. Therefore, during Mathematics learning learner actions entail cyclic events of self-monitoring, self-evaluation and self-reactions in which learners are engaged in order to adjust study habits in accordance with perceived progress towards goal attainment. In 2.4 the three phases of self-regulation are named, forethought phase, performance or volition control phase and self-reflection phase.

The third theoretically established element is the role of self-regulatory and effort management skills in Mathematics learning

During self-regulation the 'self as agent' maintains one's actions in line with the 'self' as defined by needs, emotional preferences, values and beliefs. The constituents of the volition strategy enhancement model are grounded on the assertion of Weinstein *et al*. (2011:47) in 2.3, stating the elements of self-regulation. De Corte *et al*. (2004:369) state that active and constructive learning is an effortful and mindful process in which learners actively construct their knowledge and skills through reorganisation of their already acquired mental structures in interaction with the environment. Volition is needed when motivation and goal commitment are already established, but the learner must still sustain and support the decisions that have been made. In 2.4 the necessity for self-regulation intervention to enhance goal pursuit as a result of specific learning problems encountered by learners validates the volition model.

The fourth theoretically established element is the Personality Systems Interaction theory as basis for volition

In 2.4.1 an addition is made to the theory of planned behaviour by describing how the conscious and non-conscious mechanisms which comprise volitional efficiency; that is, the functional processes that address how operational behaviour is achieved. The significant role of emotion and coping systems in the mid-level in guiding behaviour through positive and negative affect systems, which regulate approach and avoidance, is highlighted.

The fifth theoretically established element is the education system model: inputs (antecedents), processes inside the classroom, implemented curriculum, teaching, instruction and outputs

In section 3.2.1 the education system model as proposed by Howe (2004:153) which contains firstly the antecedents as input (these are teacher characteristics and the background of the learner), secondly different processes inside the classrooms, namely implemented curriculum, teaching and instruction and thirdly achievement together with attitudes towards subject as output are discussed. The teacher's task is to mediate the goals of the curriculum in such a way that the desired self-relevance perceptions are developed. In view of the prevalent background of the learners as outlined in par 3.2.1.2 there is need to raise the self-concept of the learner (about having difficulty with mathematics), persistence and purposive striving attitude as well as importance of Mathematics to the learner. Both the teacher's orientation toward a curriculum and teaching as persuasion influence how a learner engages materials in the classroom as much as the curriculum itself. The theoretically established elements contribute to the construction of volition model.

6.3.2 Summary of findings emanating from quantitative research

The volition intervention model was designed to support for volitional control during Mathematics learning. The intervention model comprised of four stages of pre-action phase (goal initiation, planning and energy usage), action phase or volition control (intention monitoring and attention control), effort regulation (volitional self-efficacy, self-control pressure) and post-action phase of self-regulation (emotion control, failure control and self-reflection). The intervention was implemented to support Grade 9 Mathematics teaching and learning in two rural community schools. The effects of volitional control support on learners' goal setting and planning ability, energy usage, volition control, emotions, effort regulation, and Mathematics achievement were examined.

6.3.2.1 Determining Mathematics learners' use of volitional strategies

Volitional strategy was assessed utilising adapted VCI (Kuhl & Fuhrmann, 1998:26)). The 68 item assessed the frequency of volitional strategy use. The 7 point Likert-type scales assessed the frequency of volitional strategy use within mathematics context asks the learner to indicate their use of meta-volitional enhancement strategies in close connection to planning and initiating, intention monitoring, attention control, failure and emotional control and their technique for regulation of effort within mathematical context. The internal consistency reliability for each scale/sub scale was estimated using the Cronbach α coefficient. The benchmark aligned in conjunction with Fadare et al., (2011:218) were the reliabilities of α ≥ 0.50–0.70 that were considered sufficiently reliable for use in group comparisons (see section 5.2.1.1 table 5.1).

As well volition enhancement was measured from a construct-validation perspective. Construct validity for this study was assessed by means of confirmatory factor analysis, as described by Van Aardt and Steyn (1991: 47). Confirmatory Factor Analysis (CFA) was performed to determine whether a one-, two, three-, or five-factor solution best fit the VCI items. Van Wyk and Van Aardt (2011:172) highlight that a scale displays good construct validity when one (the ideal) or only a few factors are extracted, which together explain a substantial proportion of the variance, and when high communalities are obtained for each statement. Communality is the percentage of variance a variable shares with the common factors on the diagonal (Reise *et al.* 2000:294). A final communality value >0.3 implies (Van Aardt & Steyn, 1991:44; Van der Walt, *et al.*, 2008: 294) acceptable construct validity (Smit, 2009:338). In 5.2.1.2 table 5.2 the results indicate that for the all VCI scales as used, lack of energy, planning and initiating, self-control pressure, intention monitoring, attention control, self-efficacy, emotional control and failure control communalities were > 0.3 which implied acceptable communalities and construct validity. There were differences observed between pre-, post and retention tests suggesting effect of volition intervention activities.

To examine the group equivalence before the treatment group interacted with the volitional control support, one-way ANOVAs were performed to investigate the difference between the treatment and control groups in dependent variables using pre-survey responses and first exam scores. The results indicated that there was no initial difference between the two groups: self-control pressure, $F(1,115) = 34.84$ ($p = 0.00$) and $F(1,115) = 1.13$ ($p > 0.05$), intention monitoring, $F(1,116) = 1.42$ ($p = 0.24$) and $F(1,116) = 1.96$ ($p > 0.05$), lack of energy, planning and initiating $F(1, 124) = 7.002$, ($p = 0.01$) and $F(1, 124) = 0.018$, ($p > 0.05$), attention control, $F(1, 114) = 3.973$, ($p = 0.049$) and $F(1, 114) = 0.024$, ($p > 0.05$), volitional self-efficacy, F(1,107) = 2.226 (p = 0.139) and F(1,107) = 0.160 (p > 0.05), emotion control, F(1, 112) = 0.249 (p = 0.619) and F(1, 112) = 0.571 (p > 0.05) failure control F(1, 95) = 4.023 (p = 0.049) and F(1, 95) = 0.502 (p > 0.05) and achievement F(1, 153) = 4.59 (p = 0.033) and F(1, 155) = 0.030 (p >0.05).

6.3.2.2 To determine learners' self-evaluation of their own effort and understanding in Mathematics after enhanced volitional strategies intervention.

To investigate if there were significant differences between the treatment and control groups in the changes of their effort management and self-regulation, their volition self-efficacy, emotion control, failure control and self-control pressure were analysed through repeated measures ANOVAs with two measurements: one before and the other after the treatment group interacted with the volitional control support. Results revealed that there was a significant Time x Group interaction for self-control pressure, F(1,115) = 34.84 (p = 0.00) and failure control F(1, 95) = 4.023 (p = 0.049) but not for volitional self-efficacy, F(1,107) = 2.226 (p = 0.139) and emotion control, F(1, 112) = 0.249 (p = 0.619). The value of p < 0.05 indicates statistical significance, hence for self-control pressure and failure control there was a significant change in participants' strategy usage between the two measurement points and the changes depended on which group they were in.

But in table 5.11 the LS means crossover data with two measurements: one before and one after the treatment group interacted with the volitional intervention model reveal reduced differences from baseline in period 1 (0.249; 95%; CI; -0.001, 0.499), p=0.033 and period 2 (0.188; 95% CI; -0.062, 0.432), p=0.139. In the experiment group there is reduction in LS means differences in comparison to the control group. The reduction significantly favoured intensified volitional self-efficacy. LS means crossover t-tests for emotion control, failure control and self-control pressure in tables 5.12 to 5.14 show similar reduction trend for the experiment group after increased interaction with the volitional intervention whereas the control group's decreased.

6.3.2.3 To determine learners' self-evaluation of their own volition control and self-regulation in Mathematics after enhanced volitional strategies intervention

To investigate if there were significant differences between the treatment and control groups in the changes of their volition control and self-regulation their planning and initiating, energy usage ability, intention monitoring, attention control were analysed through a repeated measures ANOVA with three measurements: one before and the other two after the treatment group interacted with the volitional control intervention. Results revealed significant Time x Group interaction for lack of energy, planning and initiating, $F(1, 124) = 7.002$, ($p = 0.01$) and for attention control, $F(1, 114) = 3.973$, ($p = 0.049$) but no significant Time X Group interaction for intention monitoring, $F(1,116) = 1.42$ ($p = 0.24$). This result indicates that changes in volition control, in particular attention control, energy usage, planning and initiating depended on which group participants were in.

But LS means crossover data, with two measurements: one before and one after the treatment group interacted with the volitional intervention model yielded different results for intention monitoring. When using LS means crossover t-test for energy usage, planning and initiating, table 5.15 shows, period 1 (0.199, 95%, CI; 0.018, 0.381), and period 2 (0.122; 95% CI; -0.053, 0.297), p=0.153. In the experiment group there was reduction in LS means differences in comparison to the control group. The reduction significantly favoured intensified energy usage, planning and initiating abilities. As well reduction in LS means difference was observed for intention monitoring and attention control in tables 5.16 and 5.17.

6.3.2.4 To determine whether Mathematics learners' volition strategies' uses predict their achievement in Mathematics?

Out of 155 participants, 2 participants without one of the two test scores had to be excluded from the Mathematics achievement data analysis. The analysis of Mathematics tests through a repeated measures ANOVA with three measurements: one before and the other two after the treatment group interacted with the volitional control intervention. In Appendix B, figure 5.10 results revealed that there was significant Time x Group interaction for Mathematics achievement $F(1, 153) = 4.589$, $p = 0.034$ and $F(1, 155) = 0.030$ ($p > 0.05$). This result indicate that before introduction of volition intervention changes in the participants' Mathematics achievement there was not much difference between the treatment and control groups. But for the experiment group Mathematics test results indicated the period effect with value of $p = 0.034$ and $F(1, 153) = 4.59$ ($p < 0.05$, at 1 degree of freedom and error of 153). Also, the value of $p = 0.000$ for the experiment group treatment effect and $F(1, 153) = 333.04$ ($p < 0.05$, at 1 degree of freedom and error of 153) suggests high statistical significance of the Mathematics test after volition intervention.

In 5.4.1 the results obtained using a three-way and nested ANOVA with value of p = 0.000 are in agreement with crossover ANOVA for the experiment group about treatment effect. Both results suggests high statistical significance of Mathematics test. These suggest some influence of volition activities exposure, exposure duration and the interaction of the treatment exposure on both learner use of volitional strategies and math performance. As well figure 5.15 data on L S mean Mathematics test scores for the experimental group and control group separated between pre-, post- and retention test indicate clear differences in learner performance. The experiment group revealed performance test scores with moderate increase from pre-test to post-test but with sharp decline between post-test and retention test. The decline showed decrease in performance with no intervention support.

The crossover LS mean differences between enhanced volition intervention score for experiment group reduced from 13.30 baseline in period 1, Current effect: $F(1, 153)=339.04$, $p=0.000$ to -3.97 in period 2. The decrease significantly favoured mathematics test scores after enhanced volition strategies use intervention. The significant LS mean difference between experimental and control groups suggests that the structure or process represented by the volitional items were instrumental in mathematics test performance. The effectiveness of volition intervention in improving both the functional level and mathematics performance as evidenced by high and low achievers were endorsed by crossing over to qualitative method of data analysis.

From the above emphasised findings presented with reference to the main aim, this researcher can provide a positive answer to research question one which states: “Do learners’ volition uses predict their achievement in Mathematics?” Indeed, as Mathematics tests evidence in 5.2.2.4 and 5.4.1 highlight the educational intervention enhanced Mathematics performance.

6.3.2.5 Findings on the percentage of variance due to between group variation (partial eta-squared) and effect sizes for VCI per fields

Findings are summarized and discussed in the following. First, there was no significant difference between the experiment and control groups at the beginning of this study. However, the learners who interacted with the volitional control support exhibited more positive changes in their perception of effort regulation and understanding after the intervention than the learners who did not receive the support. This finding is consistent with our expectation that effort regulation and volition control would be highlighted via tailored evaluation that involved asking learners about their perception of the intervention and providing strategies according to their responses to diagnostic questions. The size of the statistically significant effect ($ŋ^2_p$ = 0.23) of the volitional control support on self-control pressure. The size of the statistically significant effect ($ŋ^2_p$ = 0.23) of the volitional control support on effort regulation was above ($ŋ^2_p$ = 0.14) and is of large effect. It is the variance believed to be explained with knowledge of experimental group on learner self-control pressure. Thus, it appears that the presence of the volitional control support positively influenced self-control pressure.

The effect size of the volitional control support on effort regulation for energy usage, planning and initiating ($ŋ^2_p$ = 0.05), volitional self-efficacy ($ŋ^2_p$ = 0.042), failure control ($ŋ^2_p$ = 0.041) and attention control ($ŋ^2_p$ = 0.034) were significantly different and between small ($ŋ^2_p$ = 0.01) to medium ($ŋ^2_p$ = 0.06) in magnitude. There were no significant differences in effect sizes for intention monitoring and emotion control.

6.3.2.6 Findings between control and experimental group using a three way and nested ANOVA on both learner use of volition strategy use in pre - / post - and retention tests.

The experiment group results in 5.2.2.3.1 figures 5.9 to 5.15 reveal the following responses from pre-test to post-test, a sharp increasing effect of intervention, but decline between post-test and retention test when intervention is crossed over to control group for intention monitoring, attention control, self-control pressure, energy usage, planning and initiating ability, volition self-efficacy and failure control. The results of the control group between post-test and retention tests show that the control group benefits as well after the introduction of the intervention as indicated by slight flattening or increasing variation for after introduction of mentioned volitional strategies.

6.3.3 Summary of findings emanating from qualitative research undertaken using interviews and volition observation tool

The researcher used interviews and volition observation tools to assess learner effort management towards goal maintenance, volition control for self-regulated learning and self-evaluation on own progress towards goal attainment.

6.3.3.1 Reflection on the above observation

In 5.4.1.1, a comparison of high and low achieving learners revealed an analysis of the reported reasons that were different with regard to use of each volition strategy in question during Mathematics learning. In particular high performing learners have more sense of planning than low achievers in Mathematics (par 5.4.1.1.1). Learners who often monitor their Mathematics intentions out-perform learners who seldom monitor their intentions (par 5.4.1.1.2). Low Mathematics performers are often easily distracted while high achieving learners know how to concentrate and control their attention (par 5.4.1.1.3). High performers use self-talk to exert more self-control pressure while low achievers rarely report using any self-talk but give up easily when faced with challenging Mathematics tasks (par 5.4.1.1.4). In par 5.4.1.1.5, high achieving learners know how to control their emotion and react readily towards correction while low performing learners do not know how to handle their moods. Subsequently high performing learners display high volitional self-efficacy while low performing Mathematics learners have low self-efficacy (par 5.4.1.1.6).

6.4 CONCLUSIONS

6.4.1 The specific objectives of the research project is:

To develop a Mathematics teaching and learning model that will support learner use of planning and initiating, intention monitoring, attention control, self-control pressure, failure and emotional control, and volitional self-efficacy.

From the findings of the literature review, the quantitative and qualitative investigations, which led to the proposed volition strategy use construct, the following critical constituents for a volition enhancement self-regulation model have been identified:

The upheld learning views entails making use of the activity theory and constructivist model to achieve during Mathematics learning (see par 6.3.1)

- Self-regulated learning is an important factor for effective learning, hence self-regulation forms the framework of designing the model (see par 2.4.1)
- The three phases of self-regulation cycle during the process of learning: the pre-action phase(see par 2.5), the action or volition control phase (par 2.6 & 2.7) and the post-action phase (par 2.8) form the supports of the model

- Knowledge of learner procedural fluency through use of learning strategies and self-regulatory processes of meta-cognitive or cognitive self-regulation skills (par 3.1)
- The antecedents like teacher characteristics, processes in class, like teaching, identified as contributory structures towards Mathematics achievement and hence the development of volition model (see par 3.2)
- Both learner and teacher understanding of significant role of self-reflections in the post-action phase (par 2.8.1) to evaluate the result of his or her effort and effect changes in learning approach in reaction to failure (see par 5.4.1.1.5).

6.4.2 Validity and normality

The findings confirm that the VCI showed a high Cronbach α which indicates that the test is reliable and construct valid seen from factor analysis and final communality (par 5.2.1.1 and par 5.2.1.2). For all the fields the final communality values were larger than 0.3 for most of the phases, which implied acceptable communality and acceptable construct validity for the VCI questionnaire. Although the VCI questionnaire has shown reliability and construct validity, one cannot claim satisfactory construct validity only in the case of energy usage, planning and initiating ability; hence in discussion each was treated independently. In addition, the residuals behaved reasonably like samples from a normal distribution with least square means (see par 5.2.1.2.2).

6.4.3 The second objective of the research project is

To identify Mathematics strengths and weaknesses learners develop when their sense of self-control pressure, volitional self-efficacy, failure and emotional control, planning and initiating, intention monitoring, attention control, use was increased.

The following learner strengths and weaknesses in effort management that impacts volition mode of self-regulation have been identified:

In section 5.2.2.1 results were obtained through use of Univariate Tests of Significance, Effect Sizes, and Powers with partial eta^2 values. The intervention improved learners' self-evaluation of their own effort management as displayed in self-control pressure, volitional self-efficacy, emotion and volition control results.

In section 6.3.2.5 the positive effect findings are meaningful because, to enhance volition, there should be the goal set to pursue and effort regulation not to give up on goal despite distractions or failure. And to pursue the set goal, effort regulation is critical. These results extend the present understanding of the relationship between planned behaviour and volitional strategy use to improve achievement. Specifically need for achievement has consistently been associated with volitional aspects of planning and monitoring of Mathematics learners' problem-solving processes (De Corte *et al.* 2004:369). As well, self-efficacy belief prompts and the amount of explicit verbalisation needed while learners are solving problems may bring back confidence to implement intention of attempting Mathematics task at hand. Learners' use of multiple study and volition strategies can facilitate their self-regulation of failure perceptions Turner and Husman (2008:138). In the light of this, our finding that high achievers report greater use of self-efficacy enhancement is consistent with greater reported use of such strategy among those adopting mastery goals (Levpušcˇek *et al*. 2012:529).

In section 6.3.2.4 results reveal that the LS means crossover t-test indicates that the difference reduction significantly favoured intensified energy usage, planning and initiating abilities. As well reduction in LS means difference was observed for intention monitoring and attention control, volitional self-efficacy, emotion control, failure control and self-control pressure.

The crossing over of methods used for comparison and further analysis with interview themes determined some links between volition strategy use and mathematics achievement (par 5.2.2.2). The learners' effort management demands self-control which entails the inhibition of impulsive actions in order to maintain a focus on one's goals. After the intervention increased learner use of self-talk to maintain self-control pressure became a strengthening factor to dealing with internal distractions by high Mathematics achievers (par 5.4.1.1.4). On the other hand, deficient use of positive self-talk lead to low performers giving up easily on Mathematics tasks, a weakness on their part (par 5.4.1.1.4). In section 2.7.1 Orbell (2003:97) explains that self-control essentially refers to conscious processes like planning, rehearsing one's intentions, which inhibit or suppress other cognitive and emotional subsystems and processes in order to protect an on-going intention from competing alternatives.

In line the intervention improved high Mathematics performers' persistence in their efforts to continue to work hard. Learner encouragement to make use of their volitional self-efficacy became their strength to pursue challenging Mathematics tasks (par 5.4.1.1.6). Despite intervention, in contrast, the inappropriate belief of low level in self-confidence by low achievers was their weakening factor that led to the avoidance of Mathematics tasks (par 5.4.1.1.6). In section 2.5.1, Zimmerman and Schunk, (2008:37) highlight that unrealistically low self-efficacy beliefs and not lack of ability or skill may be responsible for avoidance of challenging academic courses such as math. Stevens *et al*. (2009:904) consistently reveal strong positive correlations between learners' self-efficacy and subsequent academic performance, especially Mathematics performance. Even Navarro *et al*. (2007:330) record math/science self-efficacy as belief influence that positively predicts math/science outcome expectations as both of these variables positively predict math/science interests and goals.

In harmony, another intervention strength to high Mathematics performers was their augmented knowledge of how to handle their moods by applying strategies that help them to be positive amidst challenging goals (par 5.4.1.1.5). But, on the contrary, a weakness in low achieving learners was their non-utilising of mood handling strategies when encountering challenging goals and poor reaction in response to failure. When confronted with failure or challenging goals low performing learners experience disheartened moods, are clouded with negative thoughts and ultimately avoid tackling Mathematics tasks (par 5.4.1.1.5). Emotional control forms an important aspect of volitional capacity as it describes learner's ability to regulate their emotional experience to ensure that they provide effort and complete academic tasks (Wolters, 2003:190). In section 2.7.2, research reviews bring forth evidence that suggest strong negative emotions associated with failure, such as anxiety or fear and excessive cognitive distraction resulting from failure, are known to impair learning and reduce Mathematics achievement (Perry *et al*., 2005:559). Negative emotional appraisals and expectancies lead to difficulty with the regulation and application of attention, increased disengagement and continuing negative affect, whereas favourable emotional appraisals and expectancies lead to higher levels of engagement and persistence in a given task (Blair, 2002:113). Boekaerts and Corno (2005:206) and Vermeer *et al*. (2001:313) have found that learners' willingness to maintain learning intentions and persist toward mastery in the face of difficulty depends on their awareness of and access to volitional strategies (i.e. meta-cognitive knowledge to interpret strategy failure and knowledge of how to buckle down to work). Hence learners who value Mathematics independently complete Mathematics homework by practising self-regulatory behaviours such as planning, inhibiting distractions, persisting at difficult assignments, organising the environment, overcoming unwanted emotions, and reflecting on what they have learned (Ramdass *et al*., 2011:197).

The following learner strengths in volition control that impacts on self-regulation were identified:

The intervention improved learners' self-evaluation of their own volition control and self-regulation in Mathematics as displayed intention monitoring, attention control and planning and initiating ability results (par 5.2.2.2.2 and in par 5.2.2.3). A significant main effect of intensified treatment on learner use of intention monitoring (figure 5.9), attention control (figure 5.10), learner energy usage, initiating and planning ability (figure 5.12) was observed.

The intervention improved high achieving Mathematics learners' use of intention monitoring to become aware of goal progress. The high achievers' ability to know how to encourage and force self to stay focused was their strength (par 5.4.1.1.2). On the contrary, regardless of the intervention, low achieving learners were vulnerable to making inadequate or unsuitable decisions not to stay aware of their intentions (par 5.4.1.1.2). In par 2.6.1 learning environment designed to foster interactions that support thriving mathematical communities take account of individual's maintenance of learner goal intentions. Orbell (2003:97) elaborates that during self-control conscious processes like rehearsing one's intention inhibits or suppress other cognitive and emotional subsystems and processes in order to protect an on-going intention from competing alternatives. While Wolters and Rosenthal (2000:817) explain that learner use of intention monitoring serves as one mechanism through which attitudes translate into greater effort and persistence at Mathematical tasks.

The intervention raised high achieving learners' awareness of how to ignore any distractions, what to focus on during Mathematics activities and how to use self-talk to promote concentration on their work to assist them in learning control (par 5.4.1.1.3). In contrast, lack of ability to concentrate completely on Mathematics and being easily distracted were the limitations of low achieving learners (par 5.4.1.1.3). In agreement with results, section 2.5 emphasised Kehr's (2004:485) claim that volitional regulation suppresses unwanted implicit behavioural impulses, for example avoiding wandering thoughts when one intends to work on Mathematics at hand. In section 2.6.2, with regard to self-regulation skills for regulating one's volitional processes, the results are in step with De Corte *et al.* (2004:369) who contend that volitional self-regulation involves keeping up one's attention and motivation to solve a given problem. Even Orbell, (2003:98) has observed that individuals report the operational availability of implicit attention control in some situations, and also during Mathematics learning. Pape *et al*. (2003:182) assert that during the volition control phase learners monitor and control their behaviours, cognitions, motivations, and emotions by enlisting strategies such as attention control, encoding control, self-instruction, and attributions.

The other effect of intervention that became a strength to high performing Mathematics learners was their ability to take control of time by making use of timetables or setting an alarm for reminders on homework. These undertakings contributed to high performers' planning and subsequent initiation of learning action (par 5.4.1.1.1). However, despite intervention, lack of any form of planning or being engaged in figuring out steps needed to get to the correct answer by low performing learners was a weakness on their part (par 5.4.1.1.1). In section 2.5.2 the results concur with Debellis and Goldin, (2006:132) who hint that learner acquisition of Mathematics concepts is facilitated by meta-cognitive control processes that include planning. Even literature by Pape *et al*. (2003:182) report that the learning phase characterised by plans to initiate the behaviour at a specific time and place is volitional. Kim and Keller (2010:410) mention planning and making a commitment to the goal as strategies that can help learners take action towards achievement of learning goals. Diefendorff and Lord (2003:366) assert that when learners adhere to plans, it has volitional benefits of helping learners overcome problems of action by persisting despite difficulties and completing tasks faster.

6.4.4 The third objective of the research is

To examine the effects of intervention on enhanced intention monitoring, attention control, planning and initiating, self-control pressure, volitional self-efficacy, emotion and failure control on learner Mathematics achievement.

The evidence gathered in 5.2.2.2 and 5.2.2.3.1, using crossover ANOVAs and a three-way nested ANOVA with intention monitoring, attention control, planning and initiating, self-control pressure, volitional self-efficacy, emotion and failure control as random factors nested in Mathematics performance revealed a significant main effect of intensified treatment on learner use of these variables (figures 5.9 to 5.15). Also in par 5.4.1 subjective summation confirms this observation of improved learner Mathematics performance. In figure 5.16 initiation of intervention to experiment group indicates increase in Mathematics performance, but withdrawal of intervention led to decline. For the control group a decline in learner performance was changed to increase with introduction of intervention.

6.4.5 The fourth objective of the research project is

To determine how application of the developed model influences teaching and learner achievement in grade 9 Mathematics classes.

In order to determine how application of the developed model influences teaching, the following perspectives of researcher as teacher were considered:

The knowledge of the teacher about what the components of effective Mathematics instruction are, teaching for conceptual understanding, developing learner's procedural literacy, and promoting strategic competence (par 3.2).

Teaching that integrates affective component of strategic learning and self-regulation (par 3.2).

Teaching that entails learner cognitive autonomy supported climate (par 3.2.1.1).

Teacher encouragement of learner regulatory activities involving volitional aspects of planning and intention monitoring, attention control, self-control pressure, volitional self-efficacy, emotion and failure control of Mathematics learners' problem-solving processes (par 6.3.2).

From the sampled group it can be deduced that teaching which persuaded learners to use volitional strategies and learners who made use of them during Mathematics learning achieved at a higher level than learners who did not fully make use of their strategies in grade 9 (par 5.4.2).

6.5 RECOMMENDATIONS

6.5.1 A volition enhancement self-regulation model

The need to improve Mathematics learner self-concept (about having difficulty with Mathematics), persistence and effort calls for integration of volition strategy use into Mathematics teaching and learning. To this end, I propose the volition enhancement self-regulation model that will develop Mathematics learner self-regulation skills. The implication of this developmental model is to contribute towards the concept of improved Mathematics performance.

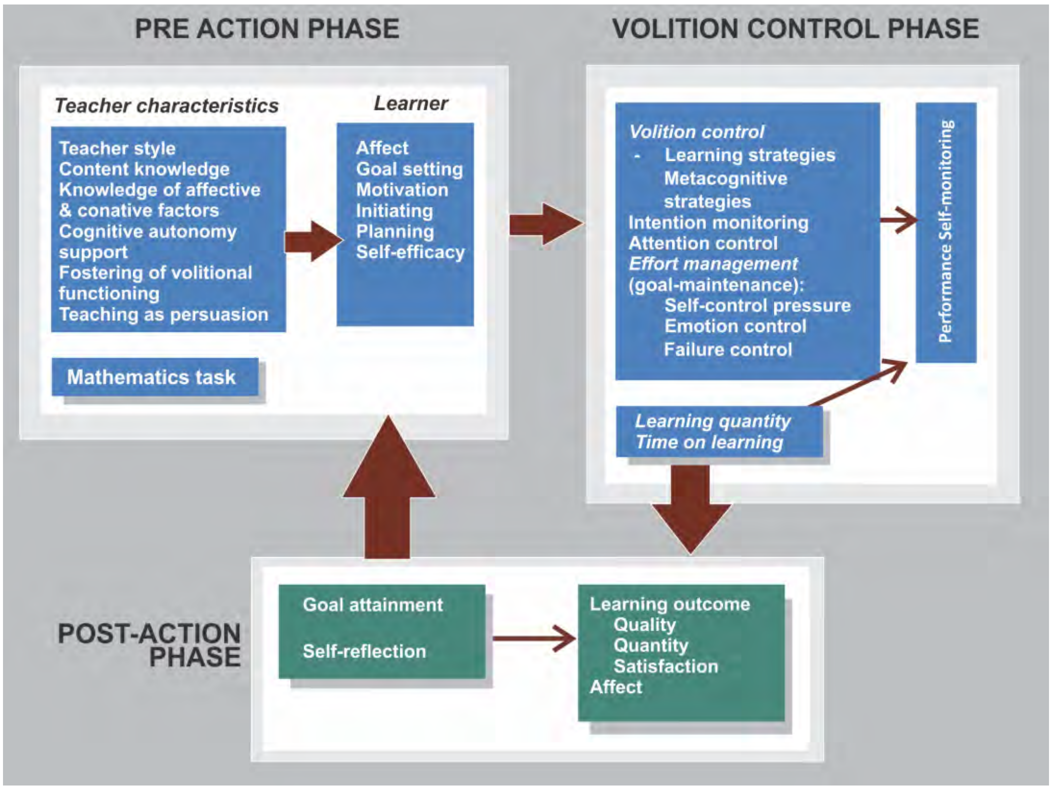


Figure 6.1 Components of volition enhancement model

The volition enhancement self-regulation model enlists as precursor, the characteristics of the teachers as input that contributes towards development of volition in view of the background of the learners. The focus on learners' characteristics in the development of volition includes the influences of teachers. The volition enhancement self-regulation model is used to describe the learning process of learners with respect to Mathematics tasks. But learning as a process is determined by learning state measurement over time. The learning state includes learning-related thoughts, affective states and activities that a learner generates to solve a given learning task within specified time period (Schmitz & Wiese, 2006:66). The intervention concept is guided by the process model of self-regulation by Schmitz and Wiese, (2006:66), and Pereis, Dignath and Schmitz, (2009:18). What is proposed is a three-phase cyclical model which focuses exclusively on state aspects of self-regulation. According to Zimmerman and Schunk (2001), the three phase model of self-regulation includes: (a) forethought, (b) performance and volitional control, and (c) self-reflective processes. The proposed model contains antecedent learning influences and effects, such as teacher characteristics, affective preconditions of learning, the actual use of learner volitional strategies, time spent on learning as well as actual learning outcomes.

6.5.1.1 Pre-action phase

It is acknowledged that teacher characteristics contribute constructively to learners' classroom motivational and volitional aspects of learner conduct. Even the teaching style determines learner engagement in class. In concurrence with Reeve (2009:163), learner engagement is a multidimensional construct consisting of four relatively equally weighted indicators (behavioural, emotional, cognitive, and voice). During problem solving, the teacher directs treatment of conflict situations into a culture of discussion and role-playing in which there may be an expression of participants' emotions and suggestions for alternative solutions and behavioural choices. Both teacher pedagogical knowledge and teacher content impact differently on Mathematics achievement (see par 3.2.1.1). Therefore the model demands that Mathematics teachers encourage volitional engagement and provide ongoing cognitive autonomy support. The appeal is in view of the fact that the teacher achieves the objective of mediating the goals of the curriculum by being persuasive. Besides, the teacher has to persuade learners to change their own behaviour or understanding, judgment or position by appealing to their reasoning and emotions.

In the pre-action phase the teacher characteristics provide the tone for basic concepts of volition mode of self-regulation processes that portray the functioning of affective responses in Mathematics learning (see par 3.2.1.1). The teacher characteristics involve being supportive by providing a learning climate where there is less learner criticism when mistakes are committed, providing warmth that encourages learner participation without fear of being ridiculed, providing learners with cognitive autonomy support, providing learners with feeling of being loved, and developing learner trust and self-confidence. The teacher should be able to persuade learners to change non-productive behaviour and be conversant with content knowledge and foster volitional functioning.

However, the learner has the responsibility to organise mental processes, affective responses, behaviours and their regulation. When learners try to self-regulate behaviour, the start is with goal setting in relation to the task. Therefore in the pre-action phase the learner is taught how to deal with factors that entail situational demands. These include the ability to initiate tasks, the ability to plan, knowing how to inhibit impulses, knowing how to focus attention, knowing how to shift attention from one task to another and knowing how to utilise working memory and motivation.

The pre-action phase highlights the importance of planning (see 5.4.1.1.1). Often on assigned Mathematics tasks, learners have to avoid procrastination and know how to handle distractions.

Procrastination implies not starting to perform the given task. One way to reduce procrastination in the pre-action phase is by embracing Orbell's (2003:97) contention that self-control conscious processes like planning inhibit or suppress other cognitive and emotional subsystems and processes in order to protect an on-going intention from competing alternatives. Hence the recognition in the model that planning has volitional benefits of helping learners completing tasks faster. It is therefore upheld that planning helps learners overcome problems of action, initiation and persistence on Mathematics tasks, despite difficulties.

The pre-action phase of the model draws attention to the concept of self-efficacy to boost Mathematics learner self-concept. Self-efficacy is the belief in one's capability to organise and perform a set of activities necessary to complete a task at a specified level of competency (Bandura, 1986, 1997; Ramdass & Zimmerman, 2008:20). It is envisaged that when expectations of success are high, binding goal commitments lead to increased effort and high Mathematics performance emerges (Oettingen *et al*., 2000:718). Hence the model includes self-efficacy in the pre-action phase and conceptualizes it as a predictor for applying Mathematics learning strategies (see par 5.4.1.1.6). As example the learner is encouraged to have faith in own endurance, think that he/she has what it takes to do Mathematics or know that they won't give up on problem easy. The feedback structure of the model simultaneously implies that self-efficacy is also effected by the learning process and learning results (e.g. satisfaction with desired outcomes should increase self-efficacy beliefs).

6.5.1.2 Volition control phase

The model assumes two basic volition control-related dimensions, volition control and effort management towards goal maintenance. Volition control is related to cognitive means by whichlearners access learning strategies. At the volition control phase learners are introduced to three different kinds of learning strategies supporting self-regulated learning: cognitive, metacognitive, and resource-management strategies (see par 3.2.2.3). The learning strategies include different ways learners deal with learning problems that promote a positive attitude toward Mathematics and learning, dealing with distractions (internal and external), concentration and coping with mistakes.

Furthermore the model maintains a theoretical viewpoint that the willingness to maintain Mathematics learning intentions and persist toward mastery in the face of difficulty depends on awareness of and access to volitional strategies. The volition strategies include learner meta-cognitive knowledge to interpret strategy failure and knowledge of how to buckle down to work on Mathematics activities. In particular the volition strategy of failure control fosters healthy ways in reaction to failure, like learner quickly learning from own mistakes, without hesitation being able to change one’s ineffective behaviour after few attempts, and being quick to accept and thus learn from criticism (see par 5.4.1.1.5). On the other hand, self-regulation for goal-striving incorporates goal-setting and goal-commitment with self-monitoring, self-evaluation, and self-reactions. During self-monitoring Mathematics learners direct cognitive attention to goal-relevant cues and make a comparison of current behaviour with the action needed for goal attainment. Therefore self-monitoring forms an integral of part of volition control phase (see par 2.4.2).

Furthermore the model broadens the volition control phase in agreement with Pape et al. (2003:182) to involve appropriate learner use of attention control, encoding control, and self-instruction, intention-monitoring in order to monitor and control their behaviours, cognitions, motivations, and emotions. For example, attention control involves learner encouragement to use self-talk to concentrate on work at hand in order to be correct at it, to ignore any distraction, to focus on the key word instruction, check correctness in substitution, calculation and start to work out or solve a problem. Among the volitional components the strategies of attention and motivation control assist learners to stop negative thoughts but to use encouraging self-talk. The evidence as stated in paragraph 5.4.1.1.3 for high performing learners who are often less distracted but know what to pay attention to, substantiates the role of attention control. In this regard regulating one's volitional processes or volitional self-regulation involves keeping up one's attention and motivation to solve a given problem. Therefore Mathematics learners use volition mode of self-regulation to support learner motivation to initiate cognitive engagement which effects changes in study habits and ultimate achievement in Mathematics.

In addition the volition control phase adopts the view of Wolters and Rosenthal (2000:817) on learner use of intention monitoring that serves as one mechanism through which attitudes translate into greater effort and persistence at Mathematics tasks. During volition control phase a learner uses skills of intention monitoring that interact with own emotions to influence maintenance of learning goal intentions. Thus learners apply necessary effort to work towards the end of Mathematics problems. For example the need to repeatedly conduct self-talk to remind self of plans and intentions in Mathematics, and to bring to mind again and again what one has to do in Mathematics and how one has to do it (see par 5.4.1.1.2).

Integrating the Personality Systems Interaction (PSI) theories, Orbell (2003:97) on planned behaviour points out that volitional efficiency is the functional processes which address how operational behaviour is achieved. The PSI theories propose that at the mid-level behaviour is guided by emotion and coping systems which are distinguished into positive and negative affect systems, which regulate approach and avoidance behaviour (see par par 2.4.1). Moreover, in par 5.3 and par 5.4.1.1.5 research observation concurs with the theory of Malmivuori (2006:153) that Mathematics experiences are connected to emotional states (feeling) and inquiry states (thinking) in which the emotional elements involve a sense of purpose, self-perception of potential for success, and willingness and capacity to monitor and control the effects of one's feelings. In this regard the model in the volition control phase recognizes the significant role of emotion control.

In the volition control phase as well learners make use of self-control pressure to ignore any disturbance whilst in pursuit of goal attainment. As example of strategies learners are to make use of self-talk to persuade self on sticking with work at hand, ignoring any disturbance, being willing to put effort into Mathematics work and put pressure on self to do it even when they feel like giving up (par 5.4.1.1.4).

6.5.1.3 Post-action phase

The post-action phase is characterized by self-reflections that contain self-judgment and evaluation procedures, including comparisons of one's behaviour with goals and attributions. The learner evaluates the result of his or her effort and draws conclusions for further learning processes (e.g., how to deal with own mistakes). Again in self-reflections the interest is in the evaluation of the quantity of learning outcome (amount of material that learner has worked on e.g. number of problems worked and time spent).

An outline of the volition enhancement self-regulation intervention

Self-regulative contents	Integrated volition strategy objective
1. Introduction of learning strategies	I. Knowledge of learning strategies II. Knowledge of cognitive learning strategies.
2. Raising learner awareness of their positive and negative "attitudes towards mathematics"	Support learners in developing a constructive and positive attitude towards mathematics
3. Goal pursuit and goal control	Support goal setting and self-monitoring
4. Self-motivation	Support learner self-confidence
5. Planning how to solve a problem and how to concentrate	Support in specific sequence of problem-solving steps I. Make decisions concerning courses of action II. Support attention/Concentration I. Reformulating self-instruction
6. Dealing with internal and external distraction	Support the elimination of any kind of internal and external distraction I. Stop and inhibit impulsive tendencies II. Identify feelings III. Think of alternative solutions to problems
7. Handling mistakes	Support learning from mistakes and immediate change of behaviour I. Failure made basis for increased focus and opportunity on Mathematics learning
8. Self-reflection	Support comparison of the result with the goal and attributions

The engagement in these outlined self-regulative contents integrated into Mathematics curriculum provides learners the means to develop volition mode of self-regulation.

6.6 VALUE OF RESEARCH

6.6.1 Subject area

The subject area of concern is Mathematic teaching and learning. During Mathematics learning the process skills are best achieved if learners are active and willingly execute appropriate actions towards goal attainment. Self-regulated learning is an important factor for effective learning. This research study contributes by providing a designed model for implementation at school based institutions. The volition enhancement self-regulation model improved learning and supported grade 9 learners' Mathematics achievement (par 6.4). In addition, the model proposes ways to support the development of advantageous learning behaviour as early as possible.

6.6.2 Research focus area

This recognition of learner volition use as a socially constructed phenomenon leads to a broadening of the research base to include a focus on schools and teachers and the development of educational policies geared toward maximizing learner's potential for success in school Mathematics. The identified strategies sustain and enhance ways of thinking as well as working and learning habits of learners involved in school Mathematics. The study falls within the scope and focus of the Focus Group concerned with the Research Focus Area Teaching-learning Organisations.

6.7 LIMITATIONS OF THE STUDY

The intervention was carried out in normal situations of actual classroom environment where there are many variables that affect the success of the design but which cannot be controlled.

6.7.1 Sample size

It is important to point out that the current data are based on a restricted sample of grade 9 learners. The effect sizes can vary as a function of sample size and sample variability. Therefore, the small sample size limits generalisability of the results.

6.7.2 Instrumentation

The research instrument relied on the self-report of the learners with English constraints which could have possibly produced responses with restricted understanding. The self-reports therefore could have possibly produced responses limiting the generalisability of the results.

6.7.3 Observation tool sheets

Learners accept and use the data observation tool sheets if a teacher tries to convince them that observation tools are a useful instrument to enhance learning. However, one cannot give them a bunch of observation tool sheets and ask them to answer a lot of questions every day without motivating them. Motivation to use observation tool sheets needs to be supported daily during the training sessions. But the compliance of the learners is not unlimited.

6.7.4 Limitation of the intervention duration

As mentioned earlier, the training lasted only eight weeks. Greater effects regarding the learning behaviour and the Mathematics achievement could be expected in case of a continuous and fairly long-term instruction of volition mode of self-regulation competencies in Mathematics classes.

6.7.5 Limitation of availability of research

There is not much research that addresses secondary school learners' understanding and use of volitional strategies.

6.8 SUGGESTED FURTHER RESEARCH

Future research into the use of these practices in primary school learners should include refinements such as follow-up assessments to determine whether additional changes emerge after development period. That is, skills that are learnt might show further development that translates into observable changes in competency after a sustained period of practice and absorption, fhus follow-up, for example, at two months and six months post intervention, could address this.

In addition, volitional self-regulatory learning strategies are more general and multidisciplinary and can be applied during the whole learning process in different content areas. Further research should investigate how volitional self-regulatory training could be integrated into existing teacher training, and what kind of methods could evaluate whether transfer of the training contents was successful.

6.9 CONCLUSION

In conclusion, the findings are intriguing in light of the significant differences that emerged showing immediate effects, after a relatively brief intervention period (eight weeks of formal intervention) in this small sample. We consider these data useful for directing attention to the application of volition enhancement programme in secondary school–age learners. Our study has demonstrated the effectiveness of volition training in improving both the functional level (self-regulation) and Mathematics performance, confirming that an integration of volition in learning could be of significance.

Mathematics learners should be given greater responsibility for their own learning and self-regulation should be taught in content areas. The study of volition strategy use suggests that a particularly promising direction for early intervention efforts may be the implementation of programmes in primary and secondary school that combine interventions focusing on social and volitional competence with early supplementary education. Such programmes would provide an exceptionally strong model for the improvement of Mathematics achievement and school success.

A secondary school version of enhanced volition self-regulation programme like curriculum combined with a supplementary education curriculum would be likely to assist learners with both the social and cognitive demands of the transition to high school. Learners in such secondary programmes would be more responsive to educational inspiration and would, on average, have more educationally encouraging information available than learners in naturally occurring classrooms. The theoretical and empirical knowledge base is in place to design and implement such truly comprehensive programmes to support Mathematics competency.

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APPENDIX A1

APPLICATION TO CONDUCT PHD RESEARCH STUDY IN MATHEMATICS EDUCATION AT SOME SELECTED SCHOOLS WITH GRADE 9

P. O. Box 8512
Rustenburg
0300

Enq. : D L Molokoli
Tel.: 014 592 1524
082 314 8460

2011-02-08

The Area Project Manager
Department of Education North West
Moses Kotane West

Dear Sir,

Application to conduct Ph D Research Study in mathematics education at some selected schools with grade 9

As a student registered with North West University for Ph D studies in mathematics education I hereby seek permission to conduct some empirical research study at some selected schools in Moses Kotane West. The schools are situated in settlement area classified as rural in Ledig. The title of the thesis is: A model for enhancing volitional strategies usage and mathematics achievement in Grade 9 in a rural community school. The study intends to reinforce identified volitional strategies that sustain and enhance ways of thinking as well as working and learning habits of learners involved in school mathematics. Reinforcement of strategies is to provide good foundation that improves performance in mathematics. Therefore this study will contribute towards improved teaching and learning of mathematics.

I hope this will meet your most considerate response.

Yours faithfully

Molokoli

D L Molokoli

NB. A letter of confirmation of Ph D studies from North West University is attached.

DEPARTMENT OF EDUCATION
NORTHWEST PROVINCE
MOSES KOTANE WEST AREA OFFICE
2011 -02- 11
TEL: 014 550-0191/92 FAX: 014 550 0
P/BAG X82110 RUSTENBURG 0300

Approved

Segodi

Area Manager

APPENDIX A2

APPROVAL LETTER FOR REQUEST TO CONDUCT PHD RESEARCH STUDY IN MATHEMATICS EDUCATION AT SOME SELECTED SCHOOLS WITH GRADE 9

education
Lefapha la Thuto
Onderwys Departement
Department of Education
NORTH WEST PROVINCE

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Private Bag X82110,
Rustenburg 0300
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Tel.: (014) 550-0192
Fax: (014) 550-0068

OFFICE OF THE AREA MANAGER: MOSES KOTANE WEST AREA PROJECT OFFICE

Enq: Ms. SP Mokomele

To : Mr D. L Molokoli
P. O. Box 8512
Rustenburg
0300

From : DA Segodi
Area Manager Moses Kotane West AO

Date : 11 February 2011

Subject : Application to contact Ph D Research Study in Mathematics education at some selected schools with grade 9

Your request to conduct research in Moses Kotane West Schools has been approved. I trust that the results of the study will be made available to the department after thesis has been completed. Any study is welcome if aimed at improving rural education.

Yours truly,

Segodi

(DA Segodi) Area Manager

DEPARTMENT OF EDUCATION
NORTHWEST PROVINCE
MOSES KOTANE WEST AREA OFFICE
2011 -02- 11
TEL: 014 550-0191/92 FAX: 014 550 0068/61
P/BAG X82110 RUSTENBURG 0300

"STAND UP, TEAM UP AND REACH OUT"
"A PORTRAIT OF EXCELLENCE"

APPENDIX B

UNIVARIATE TESTS OF SIGNIFICANCE, EFFECT SIZES AND POWERS

Appendix B

Table 5.3 (a) Univariate Tests of Significance, Effect Sizes, and Powers for self-control pressure_res

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	38.29	21.86	0.00	0.16
NO	131	1.10	0.63	1.00	0.42
phase	1	61.01	34.84	0.00	0.23
treatment	1	1.33	0.76	0.39	0.01
Error	115	1.75			

Table 5.3 (b) Univariate Tests of Significance, Effect Sizes, and Powers for Self-control pressure_res.

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	26.33	20.69	0.00	0.104
NO(Group)	132	1.17	0.50	0.99	0.367
Group	1	1.44	1.13	0.29	0.006
Error	115	2.33			

Table 5.4 (a) Univariate Tests of Significance, Effect Sizes, and Powers for Intention monitoring_res

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	1.45	1.11	0.29	0.98
NO	131	0.83	0.63	0.99	0.00
phase	1	1.86	1.42	0.24	0.02
treatment	1	3.78	2.89	0.09	0.02
Error	116	1.31			

Table 5.4 (b) Univariate Tests of Significance, Effect Sizes, and Powers for Intention monitoring_res

	Degr. of Freedom	MS	F	p	Partia eta-squa
Intercept	1	2.81	3.16	0.08	0.01
NO(Group)	132	0.85	0.64	0.99	0.42
Group	1	1.75	1.96	0.16	0.01
Error	116	1.33			

Table 5.5 (a) Univariate Tests of Significance, Effect Sizes, and Powers for Lack of energy, planning and initiating

	Degr. of Freedom	MS	F	p	Partial eta-squared	Observed power
Intercept	1	0.24	0.23	0.63	0.00	0.08
NO	132	0.44	0.47	0.99	0.33	0.71
phase	1	6.49	7.00	0.01	0.05	0.75
treatment	1	1.92	2.07	0.15	0.02	0.30
Error	124	0.93				

Table 5.5 (b) Univariate Tests of Significance, Effect Sizes, and Powers for Lack of energy, planning and initiating

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	0.114	0.238	0.626	0.001
NO(Group	133	0.439	0.434	0.999	0.318
Group	1	0.008	0.018	0.894	0.000
Error	124	1.011			

Table 5.6(a) Univariate Tests of Significance, Effect Sizes, and Powers for Volitional self-efficacy

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	0.56	0.344	0.559	0.003
NO	129	0.81	0.492	0.999	0.372
phase	1	7.69	4.680	0.033	0.042
treatment	1	3.66	2.226	0.139	0.020
Error	107	1.64			

Table 5.6(b) Univariate Tests of Significance, Effect Sizes, and Powers for Volitional self-efficacy

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	0.53	0.602	0.439	0.003
NO(Group	130	0.79	0.448	0.999	0.352
Group	1	0.14	0.160	0.690	0.000
Error	107	1.77			

Table 5.7(a) Univariate Tests of Significance, Effect Sizes, and Powers for Emotion control_res

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	2.03	1.370	0.244	0.012
NO	128	0.95	0.639	0.993	0.422
phase	1	0.37	0.249	0.619	0.002
treatment	1	0.15	0.101	0.751	0.001
Error	112	1.48			

Table 5.7(b) Univariate Tests of Significance, Effect Sizes, and Powers for Emotion control_res

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	2.10	2.109	0.148	0.012
NO(Group	129	0.95	0.640	0.993	0.424
Group	1	0.57	0.571	0.451	0.003
Error	112	1.48			

Table 5.8(a) Univariate Tests of Significance, Effect Sizes, and Powers for Failure Control

	Degr. of Freedom	MS	F	p	Partial eta-squared	Observed power (alpha=0.05)
Intercept	1	0.27	0.230	0.633	0.002	0.076
NO	121	0.77	0.644	0.989	0.451	0.827
phase	1	4.81	4.023	0.048	0.041	0.510
treatment	1	0.00	0.000	0.987	0.000	0.050
Error	95	1.19				

Table 5.8(b) Univariate Tests of Significance, Effect Sizes, and Powers for Failure Control

	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	0.14	0.172	0.679	0.001
NO(Group	122	0.76	0.611	0.995	0.440
Group	1	0.41	0.502	0.480	0.003
Error	95	1.25			

Table 5.9(a) Univariate Tests of Significance, Effect Sizes, and Powers for attention control

	Degr. of Freedom	MS	F	p	Partial eta-squared	Observed power (alpha=0.05)
Intercept	1	0.028	0.015	0.902	0.000	0.052
NO	132	1.462	0.787	0.908	0.477	0.950
phase	1	7.379	3.973	0.049	0.034	0.507
treatment	1	6.191	3.333	0.071	0.028	0.441

Error	114	1.857				

Table 5.9(b) Univariate Tests of Significance, Effect Sizes, and Powers for attention control

Effects	Degr. of Freedom	MS	F	p	Partial eta-squared	Observed power (alpha=0.05)
Intercept	1	0.121	0.081	0.776	0.000	
NO(Group)	133	1.437	0.719	0.967	0.456	
Group	1	0.036	0.024	0.876	0.000	
Error	114	1.999				

Table 5.10(a) Univariate Tests of Significance, Effect Sizes, and Powers for mathematics tests

Effects	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	1429.33	6.748	0.010	0.042
No	152	116.36	0.549	0.999	0.353
phase	1	971.94	4.589	0.034	0.029
treatment	1	71814.58	339.039	0.000	0.689
Error	153	211.82			

Table 5.10(b) Univariate Tests of Significance, Effect Sizes, and Powers for mathematics tests

Effects	Degr. of Freedom	MS	F	p	Partial eta-squared
Intercept	1	1359.77	2.022	0.157	0.013
No(Group)	151	118.81	0.177	1.000	0.147
Group	1	20.39	0.030	0.862	0.000
Error	155	672.61			

APPENDIX C

VCI QUESTIONNAIRES

Learner Name :________________ **Sex: M / F** **Grade:______**

Date : _____________ **Number:**

VCI

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

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.

Mark a cross against what best describes your response.

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

	How do I feel about working out the diffucult problem in mathematics?	**This is how often I am like that:**		
3	Simply forcing myself to do the problem.	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
11	Imposing discipline on myself.	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
19	Telling myself "You have to...".	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
27	Disciplining myself.	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 problems 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 work?	This is how often I am like that:		
35 Repeatedly reminding myself during the day of all the work I want 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
39 Forgetting to do some of the work I intended to do, even though I thought of them repeatedly.	almost never	① ② ③ ④ ⑤ ⑥ ⑦	almost always
41 Telling myself all what I want to do.	almost never	① ② ③ ④ ⑤ ⑥ ⑦	almost always
[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 important homework.	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
51 Bringing to mind again and again what I have to do.	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 mathematics class activities, doing maths homework, preparing for a mathematics test,etc.). Sometimes you are successful in starting without difficulty, and sometimes you simply cannot get going and perhaps only do so under time pressure.

What's my experience with starting and staying with a mathematics work 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 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 on my maths work and quickly letting it drop.	almost never	① ② ③ ④ ⑤ ⑥ ⑦	almost always
63	Feeling lacking energy to even get started on my mathematics work.	almost never	① ② ③ ④ ⑤ ⑥ ⑦	almost always
64	In my mind going over the details of a matter.	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
[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 work.	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
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

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:**

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
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

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:
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
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
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
[180] Deliberately thinking of pleasant things in order to become more relaxed.	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
190. Cheering up so that things will work out better.	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

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.

	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:		
202	Being able to change my ineffective behavior after few attempts.	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
209.	Easily making use of criticism to improve my approach to something.	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
[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
219	Needing little time to learn from my mistakes.	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
[226]	Quickly learning from my mistakes.	almost never	① ② ③ ④ ⑤ ⑥ ⑦	almost always

APPENDIX D

TEST 1 : QUARTERLY TEST MATHEMATICS GRADE 9

education
Lefapha la Thuto
Onderwys Departement
Department of Education
NORTH WEST PROVINCE

Mogwase Shopping Centre,
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OFFICE OF THE AREA MANAGER: MOSES KOTANE EAST AREA PROJECT OFFICE

QUARTERLY TESTS

20 March 2012

MATHEMATICS

GRADE 9

QUESTION PAPER
AND
ANSWER BOOK

NAME OF LEARNER

____

TIME: 2 HOURS

MARKS: 80

MARKS OBTAINED: ________ = ________%

IMPORTANT INFORMAT ON

1. **LEARNERS MUST ANSWER ON THE SPACES PROVIVED IN THE QUESTION PAPER.**
2. Answer all questions.
3. Write neatly.
4. Show all calculations.
5. Learners are ALLOWED to use blank sheets for ROUGH WORK
6. Learners may use CALCULATORS.

QUESTION 1

Read each question and write down the letter A, B, C or D that represents the correct answer.

1.1 The first four multiples of seven:

A: { 71; 84; 91; 108 }

B: { 7; 14; 21; 28 }

C: { 7; 14; 44; 128 }

D: { 7; 14; 21; 75 }

Answer: ____________ **(1)**

1.2 $\frac{1}{2} : \frac{2}{3}$ Write in the simplest form:

A: 3: 4

B: 4: 4 4 : 4

C: 3: 3

D: 5: 4

Answer: ____________ **(1)**

1.3 Fill in the missing measure

Speed (km/h)	Time (h)	Distance (km)
I20	7,5	x

A: 600

B: 500 500

C: 900

D: 9 000

Answer: ____________ **(1)**

3

1.4 Which of the following quadrilateral isnot parallelog ram?

A: Rectangle

B: Square

C: Rhombus

D: Triangle

Answer: ____________ (1)

1.5 Properties of similar triangles:

A: Corresponding angles are equal and the c orresponding side's are proportional

B: All four sides are equal

C: The four corresponding angles are equal and all four sides are proportional

D: No corresponding angles

Answer: ____________ (1)

[5]

QUESTION 2

$\frac{6(3-1)}{5}$; $7 - \sqrt{64}$; $\sqrt[3]{1} - 3$; 0, 316147…; $4\frac{1}{2}$; π.

2.1 From the list above select the following:

2.1.1. Natural numbers

____

____

(1)

2.1.2. Integers

____

____

____

(3)

2.1.3. Rational numbers

(4)

2.1.4. Irrational numbers

(2)

2.2 List the following:

2.2.1 The factors of 20

(2)

2.2.2 The prime numbers less than 20

(2)

2.2.3 Composite numbers between 21 and 30

(2)

2.2.4 The first four cubic numbers

(2)

2.3 What is the additive inverse of -8? 8

(1)

[19]

QUESTION 3

3.1 Increase 27g in the ratio 4 : 3

(2)

3.2 Express the following as a rate:

3.2.1 248 km travelled at 4 hours.

(2)

3.2.2 669,2 km travelled and used 70ℓ petrol.

(2)

3.3 The international call tariffs of Telkom are given in the following table

Number of minutes	3	5	9	y
Cost	R4,95	R8,25	x	R28,05

3.3.1 Is the proportion direct or indirect? Why?

(2)

6

3.3.2 Determine the cost of a 9 minute call.

3.3.3 Determine the duration of the a call if the cost is R28,05. (3)

(3)

QUESTION 4 **[14]**

On Sunday afternoon a car, a mini bus taxi and bus travel from Johannesburg to Pretoria at 58 km

4.1 Calculate each vehicle's speed for the trip

(6)

4.2

,7

(3)
[9]

QUESTION 5

5.1 Salvador bought a radio for R199 and sold it for R250. Kate bought a TV for R750 and sold it for R850.

5.1.1 Calculate the profit that each one made.

(4)

5.1.2 Calculate the percentage profit that each one made (to one decimal place

(2)

5.1.3 Who made the larger profit?

(1)

5.1.4 Who made the larger percentage profit?

(1)

5.2 Thabo invests R10 000 at 9% simple interest p.a. for 3 years. Peter invests R10 000 at 9% compound interest p.a. for 3 years.

8

5.2.1 How much money does Thabo have after 3 years?

____

____

____

(3)

5.2.2 How much money does Peter have after 3 years?

____

____

____

(3)

5.2.3 Which investment was you're your best?

____

____

____

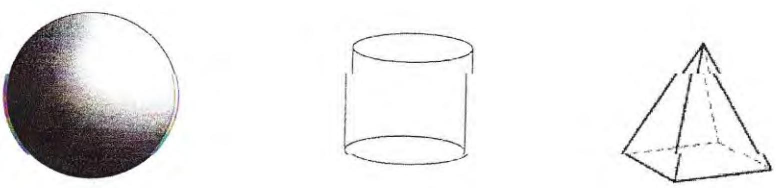
(1)

[15]

QUESTION 6

6.1 Identify the geometric figures

A: ________________ B: ________________ C: ________________



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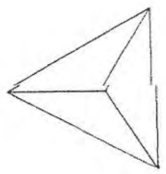
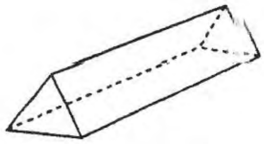
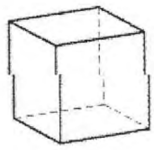
D: ______________________ E: ______________________ F: ______________________







(6)

6.2 Define a regular polygon and draw an example:

____

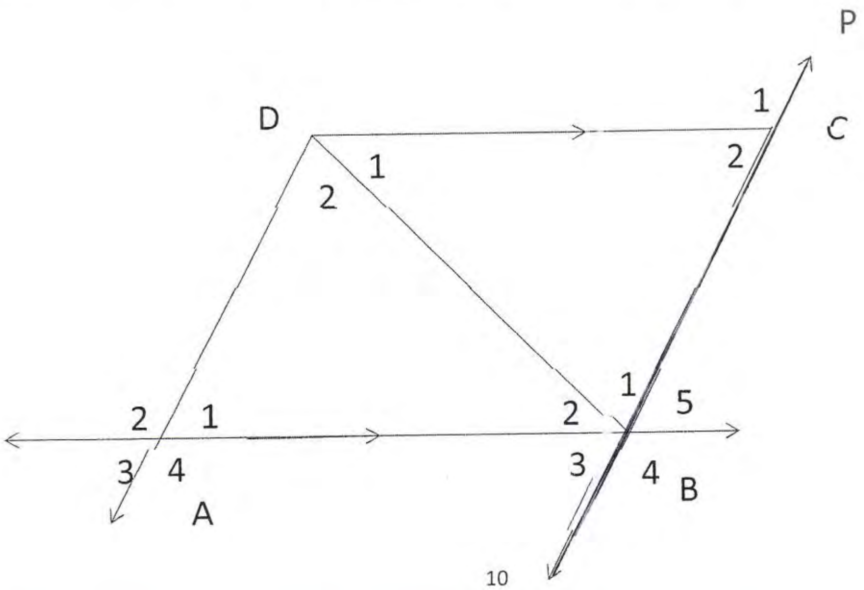
____

____

____

(3)

6.3 State whether the following statements are **correct or incorrect**.

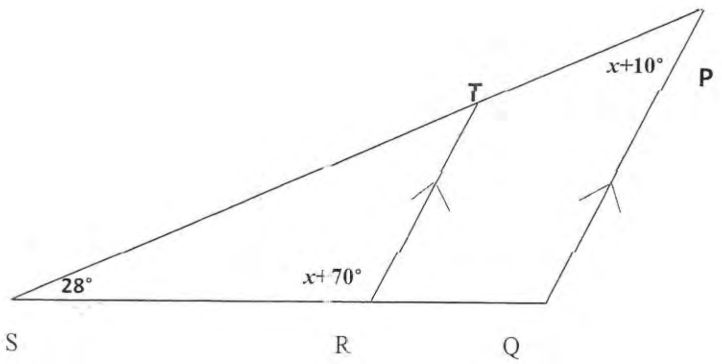


10

Eg. Statement Reason

	$A_1 \neq B_2$	incorrect	AD not parallel to BC	
6.3.1	$A_2 = A_4$	______________	Vertically Opp.	(1)
6.3.2	$\hat{C}_1 + B_1 = 180^0$	______________	Adj. Suppl. ∠'s	(1)
6.3.3	$B_1 + \hat{C}_2 = 180^0$	______________	Co-interior ∠'s AB	(1)
6.3.4	$\hat{A}_4 = D_1 + D_2$	______________	Corr. ∠'s AB	(1)

6.2 Calculate with reasons, the o f x



____

____

____

____

____

(5)

[19]

TEST 2 : QUARTERLY TEST MATHEMATICS GRADE 9

education and training

Lefapha la Thuto le Katiso
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OFFICE OF THE AREA MANAGER: MOSES KOTANE EAST AREA OFFICE

QUARTERLY TEST

12 SEPTEMBER 2012

MATHEMATICS

GRADE 9

QUESTION PAPER

AND

ANSWER BOOK

NAME OF LEARNER

____

NAME OF SCHOOL

____

TIME: 2 HOURS

MARKS: 80

MARKS OBTAINED: ________ = ________%

[1]

IMPORTANT INFORMATION

1. **LEARNERS MUST ANSWER ON THE SPACES PROVIVED IN THE QUESTION PAPER.**
2. Answer all questions.
3. Write neatly.
4. Show all calculations.
5. Learners are ALLOWED to use blank sheets for ROUGH WORK
6. Learners may use CALCULATORS.

Number of pages: 10 including the cover

[2]

QUESTION 1

1.1 Which of the following points lie on the line: $2x + y = 4$.

A (-1; 5) B. (1; -2)
C (1; -6) D. (1/2; 3) (2)

Answer: _______

1.2 The gradient(m) of the line $2y - x = -6$ is :-

A. -1 B. ½
C. 6 D. 2 (2)

Answer: _______

1.3 Which of the following is a Pythagorean triple?

A. 13; 12; 5 B. 49 ; 16 ; 9
B. 2; 1; 1 D. 2; 1; 5 (2)

Answer: _______

1.4 A fair coin is thrown in the air four times. If the coin lands with the head up on the first three tosses, what is the probability that the coin will land with the head up on the fourth toss?

A. 0 B. 1/16
C. 1/8 D. ½ (2)

Answer: _______

1.5 The root of the equation $3x - 2 = 10$ is 4. Which of these equations has the same root as this equation

A. $12 - 2x = 6$ B. $5x + 12 = 8$
B. $36/x = 9$ D. $2x - 1 = 9$ (2)
C. **Answer:** _______

[10]

[3]

QUESTION 2

2.1 Solve for x:

2.1.1 $x - 4 = 3$ (2)

2.1.2 $3x - 5 = x + 9$ (5)

2.1.3 $\frac{1}{2}x + 5 = 11$ (3)

2.2 Factorise fully:

2.2.1 $4x^2 - 4xy + 12x$ (2)

[4]

2.2.2 $4x^2-9y^2$ (2)

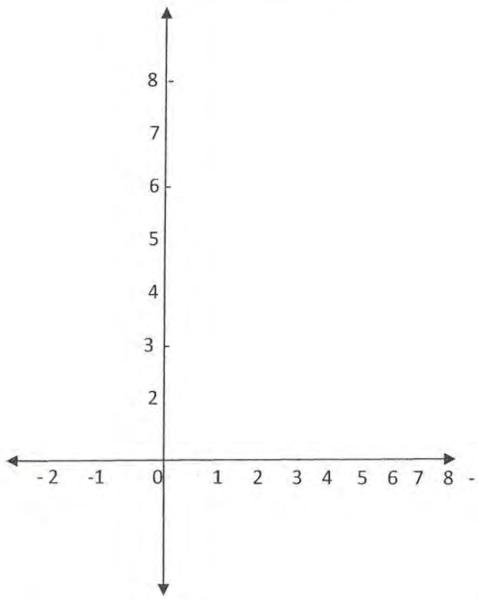
[14]

X	-2	-1	0	1	2
Y					

QUESTION 3

3.1 Use a table of values to draw the graph of y=2x+3

X ε R (choose integer values from -2 to 2) (7)



3.2 Write an equivalent description of each of the following relationships in the form given in brackets:

[5]

3.2.1 A man shares x head of cattle equally amongst his seven sons. **[Equation]**

____

____

(1)

3.2.2 Y = 200x – 51 **[Flow diagram]**

____

____

(2)

3.2.3 P→ [+2] → [X8] → [-5] → [=] →q **[Table]**

P	1	2	3	4	5
Q					

(3)

3.2.4.

Number of tickets sold	20	30	80
Income from concert tickets	R300	R450	R1, 200

[Words]

____

____

____

(2)

[15]

QUESTION 4

4.1 Write down the theorem of Pythagoras (in words)

____

____

____

____

(4)

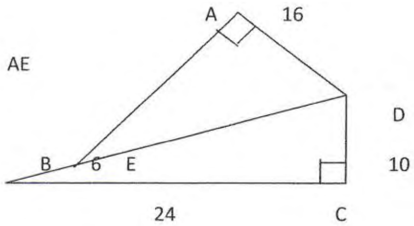
[6]

4.2 In the diagram $\hat{A} = \hat{C} = 90^\circ$

BC = 24cm; AD = 16cm; DC = 10cm; BE = 6cm

Calculate

4.2.1 AE (11)



____

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____

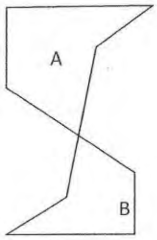
[15]

[7]

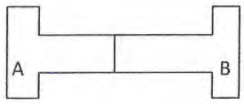
QUESTION 5

5.1 Write down whether shape B has been translated, reflected or rotated. (5)

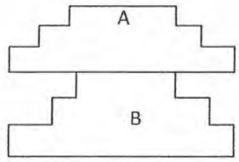
5.1.1



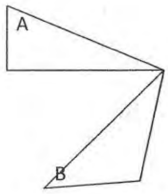
5.1.2



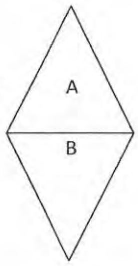
5.1.3



5.1.4



5.1.5



5.1.1. ______________________________

5.1.2. ______________________________

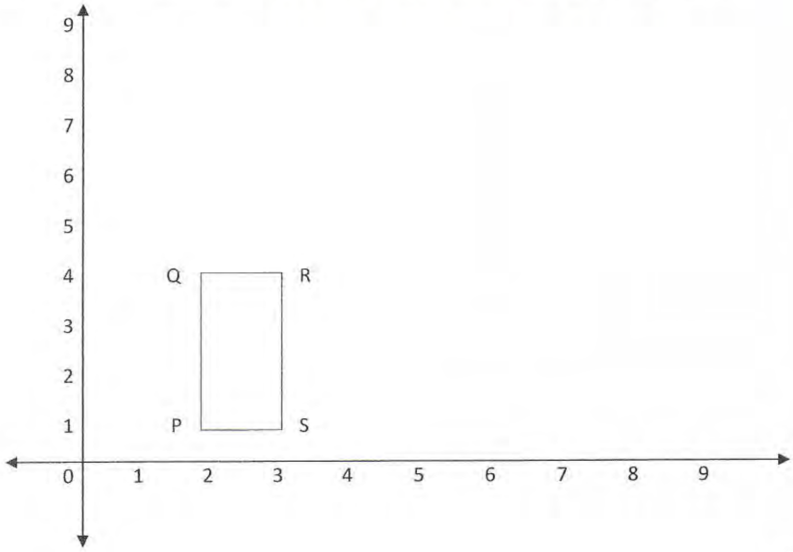
5.1.3. ______________________________

5.1.4. ______________________________

5.1.5. ______________________________

[8]

5.2 Use the squared paper to translate PQRS 4 units to the right and 2 units up.



(4)

[9]

QUESTION 6

6.1 2 Dice are thrown. What is the probability of:

6.1.1. throwing two 3 ^{s} (1)

6.1.2. obtaining a total of 7; (2)

6.1.3. the total being greater than 7; (2)

6.1.4. the total being less than 8? (2)

6.1.5 . of obtaining a four and a six (2)

6.2 A team with 2 members must be chosen from Grade 9 class.

[9]

Only Sipho; Thali and Bengi are available.

The team is chosen by drawing 2 names from hat.

6.2.1 Draw a tree-diagram to show all the possible outcomes. (4)

6.2.2 What is the probability that both Sipho and Thali are chosen?

(2)

6.2.3 What is the probability that Sipho will be part of the team?

(2)

[17]

END Total Marks [80]

[10]

TEST 3 : QUARTERLY TEST MATHEMATICS GRADE 9

education

Lefapha la Thuto
Onderwys Departement
Department of Education
NORTH WEST PROVINCE

2012

NORTH WEST PROVINCIAL ASSESSMENT

GRADE 9

MATHEMATICS

NOVEMBER 2012

MARKS : 80

TIME : 2 hours

This question paper consists of 10 pages.

INSTRUCTIONS TO LEARNERS

1. Answer ALL the questions.
2. Write your answers on the ANSWER SHEET provided by your teacher.
3. Start EACH question on a NEW page.
4. Read ALL the questions carefully.
5. Show ALL calculations from QUESTION 2 to QUESTION 4.
6. Approved scientific calculators (non-programmable) MAY be used.
7. Write neatly and legibly.

QUESTION 1

Various possible options are provided as answers to the following questions. Choose the correct answer and write only the letter (A, B, C or D) next to the question number (1.1 – 1.10) on the answer sheet.

Example:

Add the following: $2 + 3 =$ ___

A 6

B 5

C 4

D 7

Answer: B

1.1 Which of the following divisions has the smallest remainder?

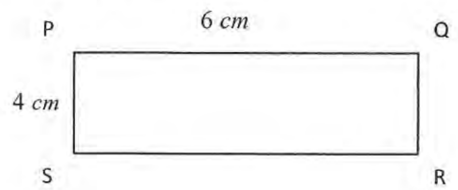
A $4002 \div 4$

B $503 \div 5$

C $604 \div 6$

D $8883 \div 8$

1.2 You want to enlarge only the length of the rectangle below by 2 *cm*. How long will side PQ be in the enlargement?



A 4 cm

B 8 cm

C 16 cm

D 24 cm

1.3 What is the product of $2{,}3 \times 10^{-5}$ and $9{,}5 \times 10^{-2}$?

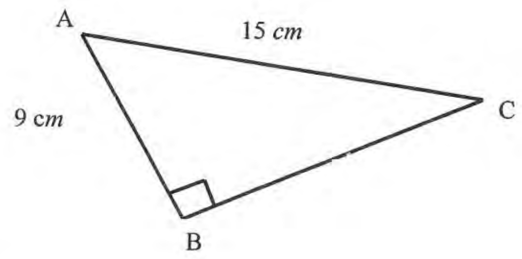
A $2{,}185 \times 10^{-6}$

B $2{,}185 \times 10^{-3}$

C $2{,}185 \times 10^{7}$

D $21{,}85 \times 10^{-6}$

1.4 Study the triangle below. What is the length of side BC if AC = 15 *cm* and AB = 9 *cm*?



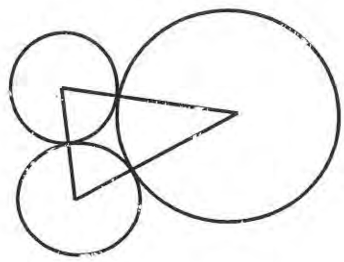
A 11 *cm*

B 13 *cm*

C 19 *cm*

D 12 *cm*

1.5 Three circles with radii 7 *cm*, 8 *cm* and 9 *cm* touch each other externally without overlapping. What is the perimeter of the triangle formed by joining the three centres of the circles?



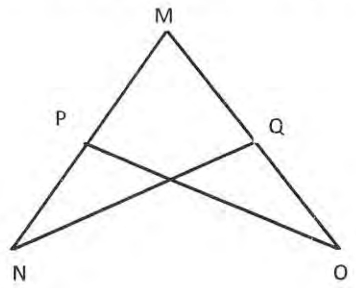
A 30*cm*

B 24*cm*

C 48*cm*

D 12*cm*

1.6 In the adjacent figure, MN = MO and MQ = MP. Why is $\Delta MNQ \equiv \Delta MOP$?



A SSS

B 90^0HS

C S∟ S

D ∟∟S

1.7 How many terms are there in the following expression?

$$4x^5 + 2x^2y - x^4y^3 + 2x^2y^2 - \frac{xy^4}{3} - 10$$

A 4

B 6

C 7

D 5

1.8 If a letter is chosen randomly from the word "MATHEMATICS," what is the probability that the letter "A" will be chosen?

A $\frac{11}{11}$

B $\frac{7}{11}$

C $\frac{8}{11}$

D $\frac{2}{11}$

1.9 Write an algebraic expression for the following:

Add 15 to the product of 3 and b.

A $15 \times 3 + b$

B $3 + b = 15$

C $3b + 15$

D $15b + 3$

1.10 The following data set are the IQ's of learners in Grade 9. What is the range of the data?

115 108 104 104 112 149 104 137 100 107 122

A 49

B 149

C 104

D 100

(10 × 2) (20)

[20]

QUESTION 2

2.1 Solve for x:

$\frac{x}{2} - 3 = 9$ (2)

2.2 Simplify:

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

2.3 Factorise completely:

$px^2 - 3p + 2x^2 - 6$ (3)

2.4 Simplify and give the answer with positive exponents:

$\frac{24a^4}{8a^6}$ (3)

2.5 Study the following table and answer the questions that follow:

x	-1	0	1	3
y	-1	1	3	7

2.5.1 Plot the points on a Cartesian plane. (4)

2.5.2 Do the points form a linear or non-linear relationship? (1)

2.5.3 Is the graph increasing or decreasing? (1)

2.6 Calculate the compound interest if R500 is invested at 12% interest per year for two years. (Use $A = P(1 + i)^n$) (4)

2.7 The sum of one third of a number and one quarter of the same number is 28. What is the number? (4)

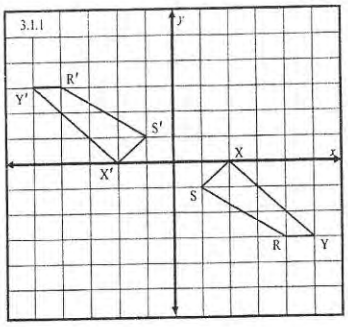
2.8 If 50 is added to a number, the number is 3 times as much as before. What is the number? (3)

[28]

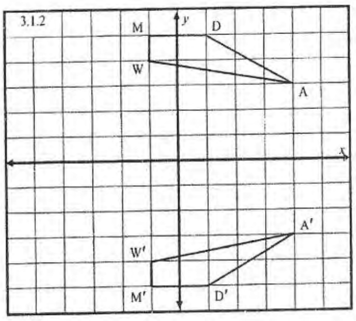
QUESTION 3

3.1 What type of transformation took place in Question 3.1.1 to Question 3.1.3? Describe the transformation.

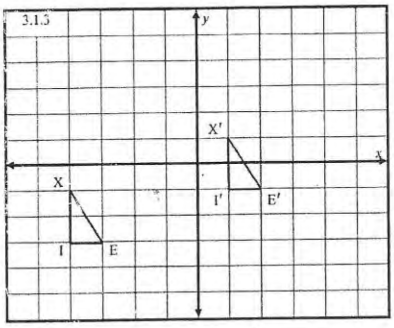
3.1.1



3.1.2



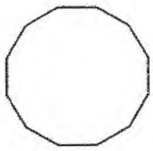
3.1.3



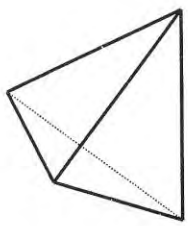
(3 × 2) (6)

3.2 Identify each of the following figures:

3.2.1

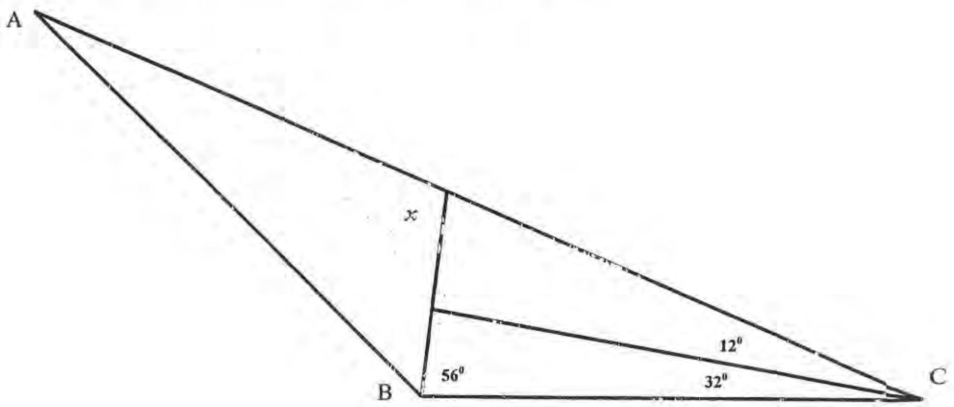


3.2.2



(2)

3.3 Determine, with reasons, the value of x in triangle ABC.



(3)

3.4 It takes two hours to travel from Rustenburg to Ventersdorp at a speed of 30 km per hour. How long will it take to travel from Rustenburg to Ventersdorp at a speed of 60 km per hour? (Distance = Speed × Time) (4)

[15]

QUESTION 4

4.1 The table below indicates the distribution of boys and girls in a school. Use the information on the table to draw a double bar graph.

	BOYS	GIRLS
GRADE 7	40	50
GRADE 8	50	70
GRADE 9	80	100

(6)

4.2 The following are the marks (out of 10) that a group of 16learners got for a class test.

6 3 8 9 5 10 7 4 6 2 7 5 8 7 3 10

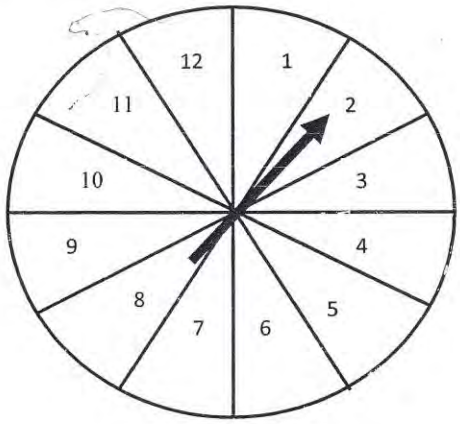
Determine the following:

4.2.1 Median (2)

4.2.2 Mode (1)

4.2.3 Mean (2)

4.3 On the spin board illustrated below, the arrow is spun. Determine the probability that the arrow will stop on the following:



4.3.1 The number 4. (2)

4.3.2 An even number. (2)

4.3.3 A multiple of 3. (2)

[17]

TOTAL: 80